

**ETHNOBOTANICAL AND ECOLOGICAL STUDIES OF SOME
MEDICINAL PLANT SPECIES IN BUNDELKHAND REGION (U.P.)**



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BOTANY

By

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DECLARATION BY THE CANDIDATE

I declare that the thesis entitled "**Ethnobotanical and Ecological Studies of Some Medicinal Plant Species in Bundelkhand Region (U.P.)**" is my own work conducted under the supervision of Dr. U.N. Singh, Reader and Head, Department of Botany, D.V. Postgraduate College, Orai (U.P.) as approved by Research Degree Committee. I have put in more than 200 days of attendance with the supervisor at the centre.

I further declare that to the best of my knowledge the thesis does not contain any part of any work which has been submitted for the award of any degree either in this university or in any other University/ Deemed University without proper citation.

Date : 23/08/06


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CERTIFICATE OF THE SUPERVISOR

This is to certify that the work entitled "**Ethnobotanical and Ecological Studies of Some Medicinal Plant Species in Bundelkhand Region (U.P.)**" is a piece of research work done by Mohini Gupta under my guidance and supervision for the degree of Doctor of Philosophy in Botany of Bundelkhand University, Jhansi (U.P.) INDIA. That the candidate has put-in an attendance of more than 200 days with me.

To the best of my knowledge and belief the thesis :

- (i) embodies the work of the candidate himself,
- (ii) has duly been completed,
- (iii) fulfil the requirements of the ordinance relating to the Ph.D. degree of the University and
- (iv) is upto the standard both in respect of contents and language for being referred to the examiner.

Date : 23.08.2006


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Date : 23/08/06

Gupta
(Mahini Gupta)

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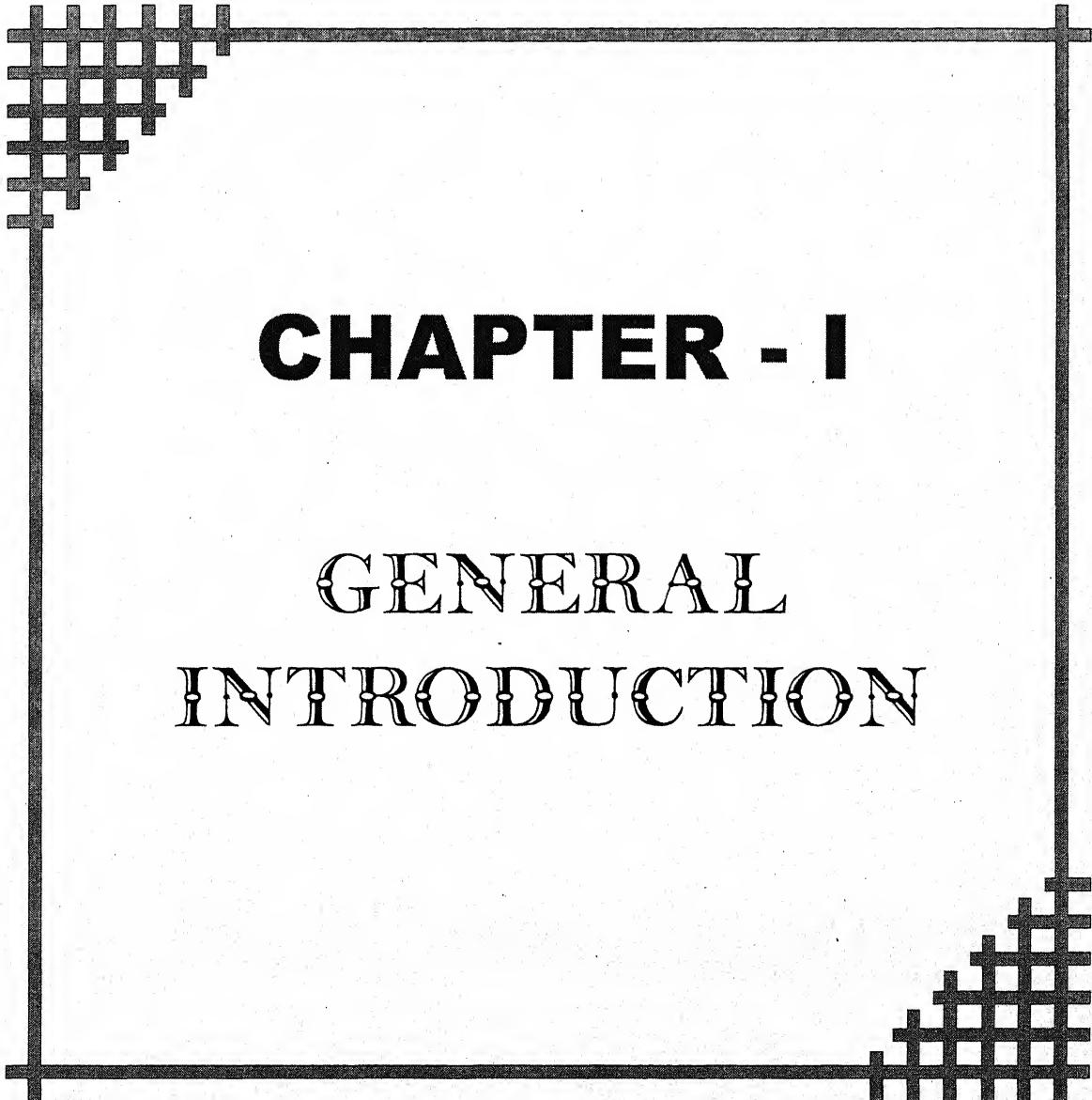
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CHAPTER - I

GENERAL INTRODUCTION

GENERAL INTRODUCTION

INTRODUCTION

Ecology deals with the mutual relationships and interactions between organisms and their physical environment.

The physical factors of the atmosphere, the climate and the soil affect the physiological functions of the plant in all its manifestations so that, to a large degree, plant ecology is a phase of plant physiology under natural and uncontrolled conditions; in fact, it has been called 'outdoor physiology'. Plants are intensely sensitive to the forces of the environment and both their association into communities and their geographical distribution are determined largely by the character of climate and soil. Moreover, the pressures of the environment and of organisms upon each other are potent forces, which lead to new species and the continuing evolution of larger groups.

The importance of medicinal and aromatic plants has been recognised throughout the world. India, one of the 12 Mega-diversity countries of the world, has a particularly rich heritage of medicinal plant wealth. More importantly, it has been documented in a number of plants of medicinal importance. The remarkable 'Materia Medica' the Charak Sanhita is an immensely

important treatise on hundred of plants of medicinal value, and is still referred to by scientists and the industry. So is the Susruta Samhita, another treatise dating back to roughly the same era (800-1000 BC).

Man completely depends on the plants for almost all the activities and requirements of life. Explosion in human population together with modernisation and industrialisation of society created much more demand for energy, food, fibre, shelter, medicine, cloth, ornament etc. Plants were thought to be the best weapon for combating ailments and as a primitive cure against diseases. Plants still form a major part of ingredient in almost all systems of therapeutics. All over the world man has attempted to utilize the flora of his respective region for the relief of ailments. The welfare of mankind is served by the species that share the earth alongwith them. They are also regarded as abodes of spiritual solace.

According to evolutionary theories and other ancient scripts, it is proved that plants have originated before human beings. The idea that plant could be used for treating diseases and healing wounds probably arose in the mind of early man and they used plant parts and their crude extract to help them in need, sorrows and sickness without the scientific knowledge of their composition. India has a great and ancient cultural heritage. Medical treatment

flourished here centuries ago when people in other parts of the world were not so advanced. The use of plants for curing various human ailments figured in ancient manuscripts as the Rigveda, the Bible, the Illiad and the Odyssey etc. In the early ages, man used raw drugs isolated or obtained from the plants lead one to infer about the inter-relationship between primitive men and medicinal plants. From a very long time, plants have been used traditionally as medicine by aboriginal people. In 19th century a good number of workers compiled literature regarding the traditional uses of plants by primitive human societies.

Potentially, every plant occurring on this planet has one or more medicinal properties. An increasing number of investigations have been developing attention to the vast stored knowledge about the properties and uses of plants, still existing in nature and in several parts of the country. But without paying attentions on traditional and ecological aspects between man and his surrounding plants, it is not possible to conserve these plants forever along with their medicinal properties. Exploitation can be sustained through the ecological studies of all species alongwith their rational uses.

Our knowledge of intimate relationship between early man and plant has come from ancestors and through tribal people i.e., by serving tradition. This attempt was baptised by John Willium

Harshburger in the year 1896 as "Ethnobotany" to indicate interrelationship between plants and aborigines. So the relationship between man and his ambient vegetation is called Ethnobotany. This subject gained importance during the past few decades under many respective interdisciplines, out of which ethnomedicinal knowledge is very ancient in India. From ancient times to date, people healed themselves with traditional herbal medicines, which in several cases is by trial and error, proved efficacious. In every ethno group there exists a traditional health care system which is culturally patterned. In tribal communities the traditional health care seems to be the first and foremost line of defence. The world Health Organisation has also recognised the contribution of traditional health care seems to be the first and foremost line of defence. The World Health Organisation has also recognised the contribution on traditional health care in tribal communities. Ethnomedicine is an area of research that deals with medicine derived from plants used by rural and tribal people against various ailments. The term ethnomedicine has been used lately to define the medicinal uses of plants in relation to human being. All indigenous remedies whether traditional or modern has been originated directly or indirectly from superstitions, rituals and folklore etc. Rich traditional skills and oral folk-lore knowledge are fast disappearing and are likely to be lost for ever. Hence, this problem must be taken as a challenge by

researchers and scientists to conserve the valuable knowledge and wisdom of the tribals for the prosperity and human welfare. So, in present day, investigations have been necessitated due to rapid depletion of natural resources on one hand and the dwindling traditional ethnic culture on the other hand.

Through the conservation of plants, man can preserve several species as botanical curiosities, useful to him and thus ensure their survival. Like other organisms plants or plant communities, germinate, grow, become mature and ultimately die. Majority of life processes i.e. reproduction, growth and field of plants are governed by various habitat factors such as climate, physiography and biotic influences etc. Vegetation plays a major key role in the structural configuration of nature and it can be managed either for physical and recreational benefits; they confer; or for productive purposes. Plants exercise a moderating influence air, water, temperature and other various factors. Besides altering the physical and chemical properties of soil, they play an important role in checking flood, drought, erosion and vagaries of nature. Several factors such as soil, rainfall, altitude, light and method of cultivation etc. play a major key role for economical success of large scale cultivation of plants. Numerous activities of man influence the growth and production of plants.

Joshi (1987) supported conservation and cultivation of medicinal herb plants. According to Arora (1989) ethnobotany and plants domestication is necessary for global prospective and security through plants conservation. However large scale cultivation of these medicinal plants for profit depends on the active principal constituents and not on their luxuriant growth. Cultivation is essential in case of drugs because supplies of the wild plant species are insufficient to meet the ever growing demand. For success in cultivation it is necessary to study the conditions under which the plant flourished in wild state. Small changes in ecological conditions can affect the growth of any plant. Soil which may have direct control on plant distribution and plant growth performance, demand more detailed consideration. According to Jain and Mitra (1990) the impact of ethnobotany in conservation of natural resources is very direct. American pharmaceutical industries depend on natural resources to the extent of 30%. Even today the message of conservation can be induced to many primitive societies through faith and tradition rather than in terms of ordinances.

The purpose of the study is to point out the potentials of medicinal plants and to explore the possibility to finding and improving new uses of plants of the area. It is worth to tap traditional knowledge, while the elderly medicinal men, who are familiar with curative values of plants are still alive. Ethnobotanist

bring out suggestions as to which plant material may be tapped and they get clues from rural or tribal men. The field has received considerable attention in India as well as abroad.

Observation and inferences, accidents and institutions, philosophy and traditions, medication and sliding into deep prolonged thought all seems to have contributed in the birth and growth of Indian system of medicine. Hence ethnobotanical studies would be more meaningful if the data so obtained are subjected vigorous experimental evaluation.

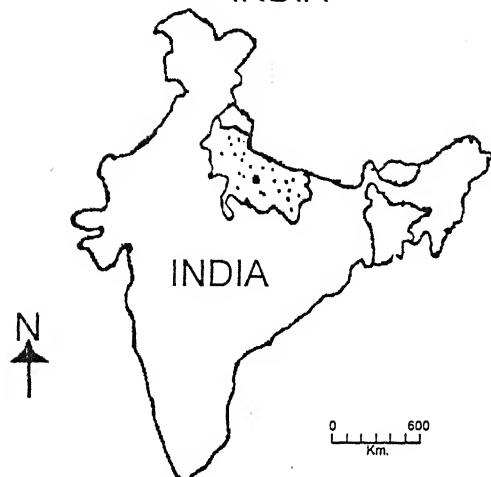
STUDY SITE

Location :

Bundelkhand region occupies a central position in the country. This tract of the country which is mostly hilly, support a good growth of grassland and scrubby forest. The area under investigation is a part of level land situated in a triangle between Yamuna river in North, Betwa river in south and Madhya Pradesh state in the west.

The Jalaun district is situated at lat. $25^{\circ} 59' N$, long. $79^{\circ} 37' E$ and 141.6m above mean sea level towards the northern part of Bundelkhand region (Fig.1).

UTTAR PRADESH
IN
INDIA



JALAUN DISTT.
IN
UTTAR PRADESH



STUDY AREA
IN
JALAUN DISTRICT

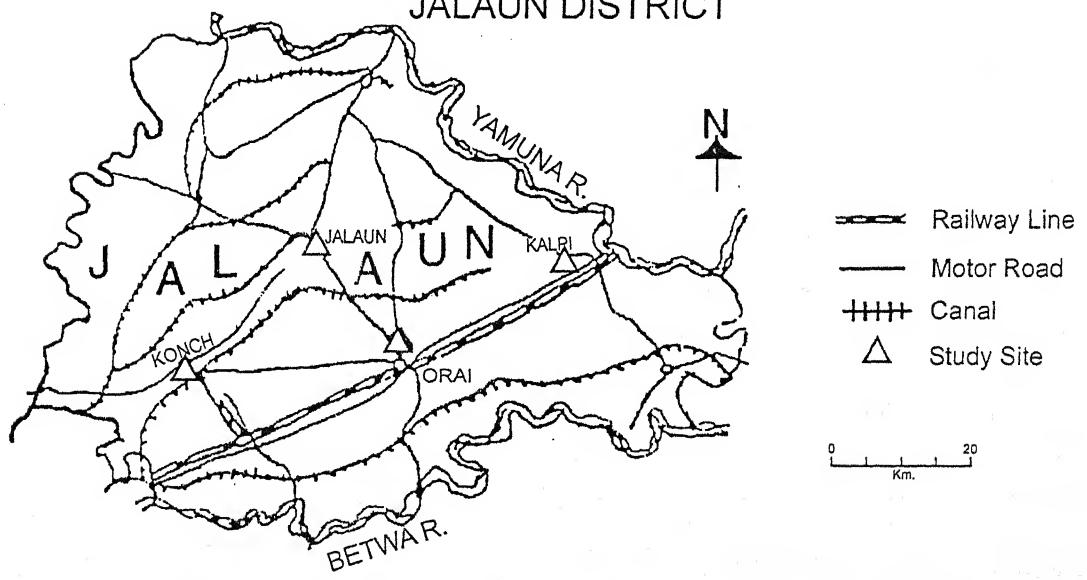


Fig.1 : Map showing the location of study sites

The total geographical area of the district is 494844 ha. Orai, Jalaun, Konch, Kalpi, Madhogarh, Ait, Jagammanpur, Nadigaon are some of the major places of the district.

Topography :

With exception of southern marginal areas the entire Bundelkhand region is marked by undulating topography, that tends to become into a perfect level plain towards north (Jalaun). It shows every where gently undulated surface with occasionally flat topped ground. Bundelkhand plain also know as trans Yamuna plain which is divisible into three- east, west running belts and Jalaun division comes under northern belt, which is the narrowest of the other two and confined along the banks of Yamuna in the form of high ground which represents the level of the ancient flood plain, but at present is badly cut into deep ravines.

Natural Vegetation :

Bundelkhand an ecologically degraded region has an estimated area of 0.64 million hectares under forest (7.2%). *Tectona grandis* Linn., *Anogeissus pendula* Edgew, *Albizzia procera* Benth., *Albizzia lebbek* Benth., *Diospyros tomentosa* Rox., *Butea monosperma* (Lamk.) Taub., *Salmalia malabarica* (CD.) Schott & Endl., *Boswellia serrata* Rox., are found in small patches. *Acacia nilotica* (Linn.) Del., *Acacia catechu* Willd. are the principal types

of acacias but not much utilized. *Carissa carandus* Linn. and *Capparis decidua* Edgew. are mostly utilized for grazing. In Orai original cover has almost been removed for inhabitation and cultivation. Shrubs and grasses represent the secondary growth throughout the region.

Lithology :

The common rocks are sand stones, lime stones and shales. The peculiar features of immense geographical interest in this region are the long narrow serrated ridges termed as quartz reefs and dolarite dykes. In the north west and north east the geological system is covered by Ganga Yamuna alluvial deposits in the form of an 'embayment'.

The Soil :

The most important soil groups of Bundelkhand are found in the northern low land (Orai.) These are Mar, Kabar, Parua and Rankar, formed partly in situ and partly by transporting agencies, chiefly by the streams. Mar is a calcareous soil, predominantly blackish in colour, mixed with lumps of Kankar. It is friable and aerated. Kankar on the other hand is highly diffused. Parua, the best known variety of the degraded red and yellow soil group is well aerated, friable and receptive to irrigation and favourable for various types of crops. Rankar is associated with

flood plains subjected to gullying and erosion, so that calcium nodules are exposed at the sloping surfaces, rendering them unsuitable for cultivation.

The soil of the stands under the present investigation consists of sand, silt, clay and kankar in the following percentages: a- fine sand 2.75%, b- coarse sand 41.70%, c- silt 21.74%, d- clay 25.00% and e- kankar 8.81%.

**Table 1.1 : Physicochemical characteristics of soil of the study sites
(composite sampling)**

Physicochemical characters	(Depth in cm)		
	0 - 10	10 - 20	20 - 30
pH	7.6	7.7	7.7
Water holding capacity (%)	39.54	40.71	41.21
Soil moisture (%)	18.76	22.90	24.81
Soil nitrogen (%)	0.068	0.059	0.035
Available phosphorus (%)	0.019	0.013	0.006
Organic carbon (%)	0.23	0.23	0.12

Thus it is medium textured and sandy loam to loam. Amongst physical characters - the soil colour of the stands (as per

Munsell Colour Chart) is light olive brown or olive brown i.e. Hue 2.5Y, 5/4 (Value/Chrome). It is acidic in reaction.

Water holding capacity is measured as proposed by Pandeya, Puri and Singh (1968). The values of water holding capacity increases with depth though very little, at all the stands during growth period.

The amount of soil moisture depends on rainfall as moderated by topography and soil depth. The average value during best growth period reveals maximum soil moisture percentage in the month of July.

A detailed account of the soil (physical and chemical) is given in the table 1.1.

Results of chemical analysis of soil samples indicate that soil is medium in total nitrogen content and poor in available phosphorus content. They revealed maximum percentage in the uppermost layer (0 to 10 cm) of the soil.

Climatology :

The region experiences a transitional climate between the marginal climate of East coast (bay of Bengal) and the tropical continental dry type of climate of west (Rajasthan).

The characteristic of the climate of this region is long, hot

and dry summer season, less precipitation and a small winter season. The year may be divided into three distinct seasons.

a- Rainy season (July to October) It is warm and wet.

b- Winter season (November to February) It is cool and dry.

c- Summer season (March to June) It is hot and dry.

The mean annual temperature of Orai is 24.8°C but mean monthly values considerably vary from their annual means (14.5 to 35.5°C) and consequently their ranges are high. On occasional nights temperature may fall down to a lowest minimum of 2°C . The intensity of the summer season increases with a very hot westerly dust laden winds called "Loo", which usually blow throughout May and June and the temperature continuously increases upto a highest mean maximum of 44.9°C in May.

Total annual precipitation comes to about 1186.8mm of which 90% falls between July to October i.e. during wet summer when the temperature fluctuates around 30°C . The onset of monsoon takes place during the end of June with maximum rainfall during July and August. Some shallow westerly depressions cause occasional winter rains which take place by the end of December upto the end of February or March. Winter accounts for only 2% of the annual rainfall.

When annual temperature and precipitation are considered together the area is warm and dry i.e. dry subhumid.

With respect to wind, because intensity of rains and temperature variation will depend upon the direction of wind, it blows over the area running from Bay of Bengal obliquely South East to North West direction in July. In winter months the direction of wind changes from North West to South East. During summer the wind is westerly with a maximum velocity of 5.3 Km per hour in May. Percentage relative humidity (mean monthly) of the area vary from 22.2 to 73.1%.

The details of the climate are given in table 1.2 & fig.2. According to Gaussen (1960) the effectiveness of climatic factors like temperature, precipitation and length of dry period can be understood in a better way by means of Ombrothermic diagram (fig.3). This is done by bringing out the elements on a graph. On the abscissa are marked the months, on ordinates to the left the temperature and to right the rainfall.

For tropical regions, where the mean monthly temperature is about 25°C , rainfall under 50mm, would classify a month as dry. Thus the Ombrothermic conditions of the area revealed 8 dry months and 4 wet months during a year.

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Table 1.2 : Climatic data of Jalaun (Orai) 2004-2005

Months	Temperature ⁰ C			%Relative humidity			Wind velocity Km/hr mean	Rainfall (mm) monthly	Incident Energy K cal/ m ² x10 ³ / day
	Mean		Mean	Mean	Mean	Mean			
	Max.	min.	month	morn.	even.	month			
2004									
July	34.0	24.1	29.0	78.0	67.0	72.0	2.0	615	67.73
August	32.8	23.9	28.8	73.7	72.5	73.1	2.8	194.8	52.70
September	31.9	23.5	27.7	66.5	66.7	66.6	2.9	169.7	52.20
October	32.1	20.0	26.0	60.0	52.0	56.0	1.8	69.0	64.63
November	31.1	15.0	23.0	50.0	38.0	44.0	1.7	3.4	50.40
December	24.5	7.6	16.0	57.5	43.8	50.6	2.0	5.0	48.20
2005									
January	23.5	5.5	14.5	51.8	45.7	48.7	2.0	8.4	53.78
February	22.4	6.8	14.6	44.3	46.3	45.3	3.0	2.0	59.64
March	30.7	13.6	22.0	50.6	38.6	44.6	3.0	19.3	67.89
April	38.0	20.1	29.0	37.3	18.0	27.6	3.5	1.0	76.80
May	44.9	26.2	35.5	25.4	19.0	22.2	5.3	-	82.46
June	39.2	25.0	32.1	50.0	40.6	45.3	4.4	99.2	75.90

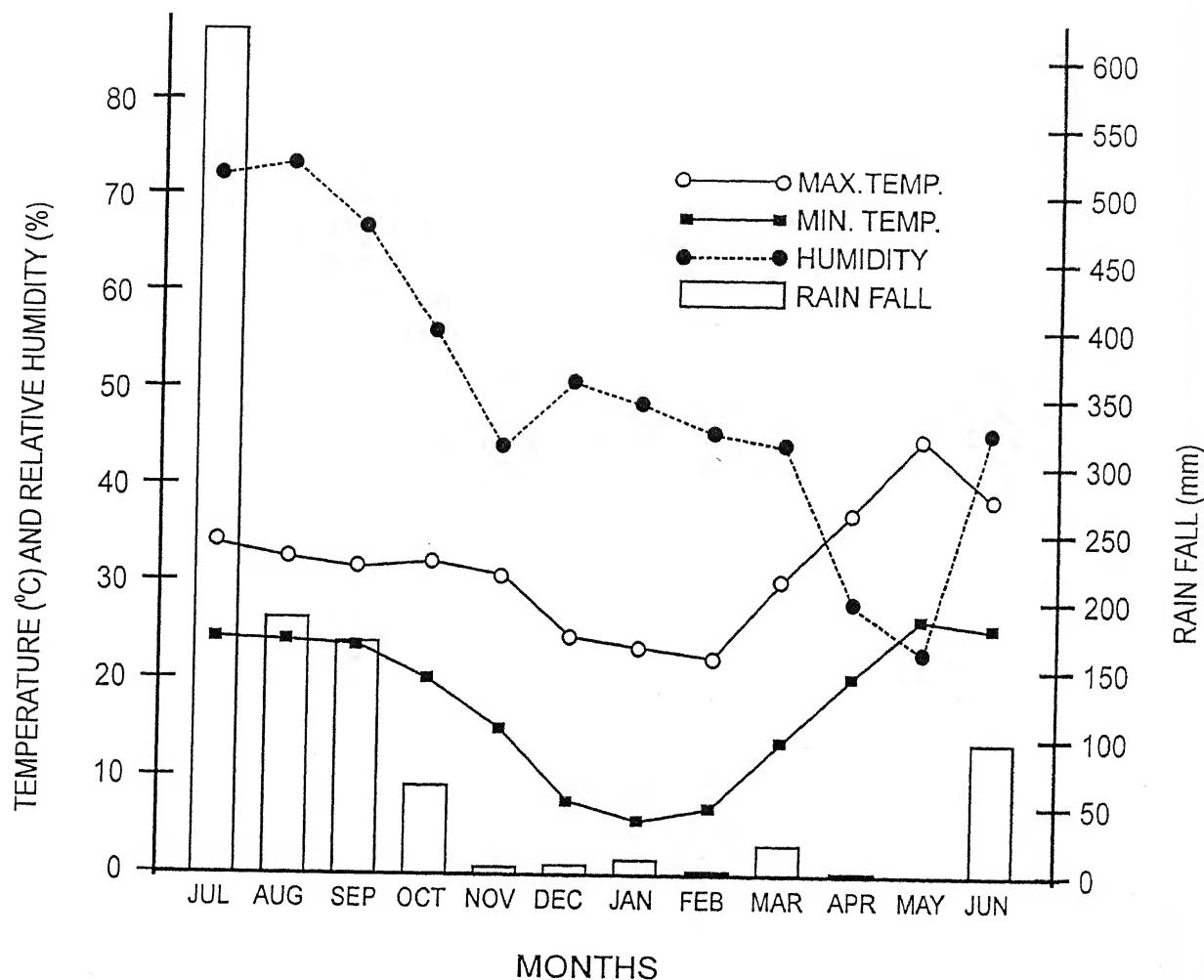


Fig. 2 : Climatic condition at Orai (Jalaun) 2004-2005

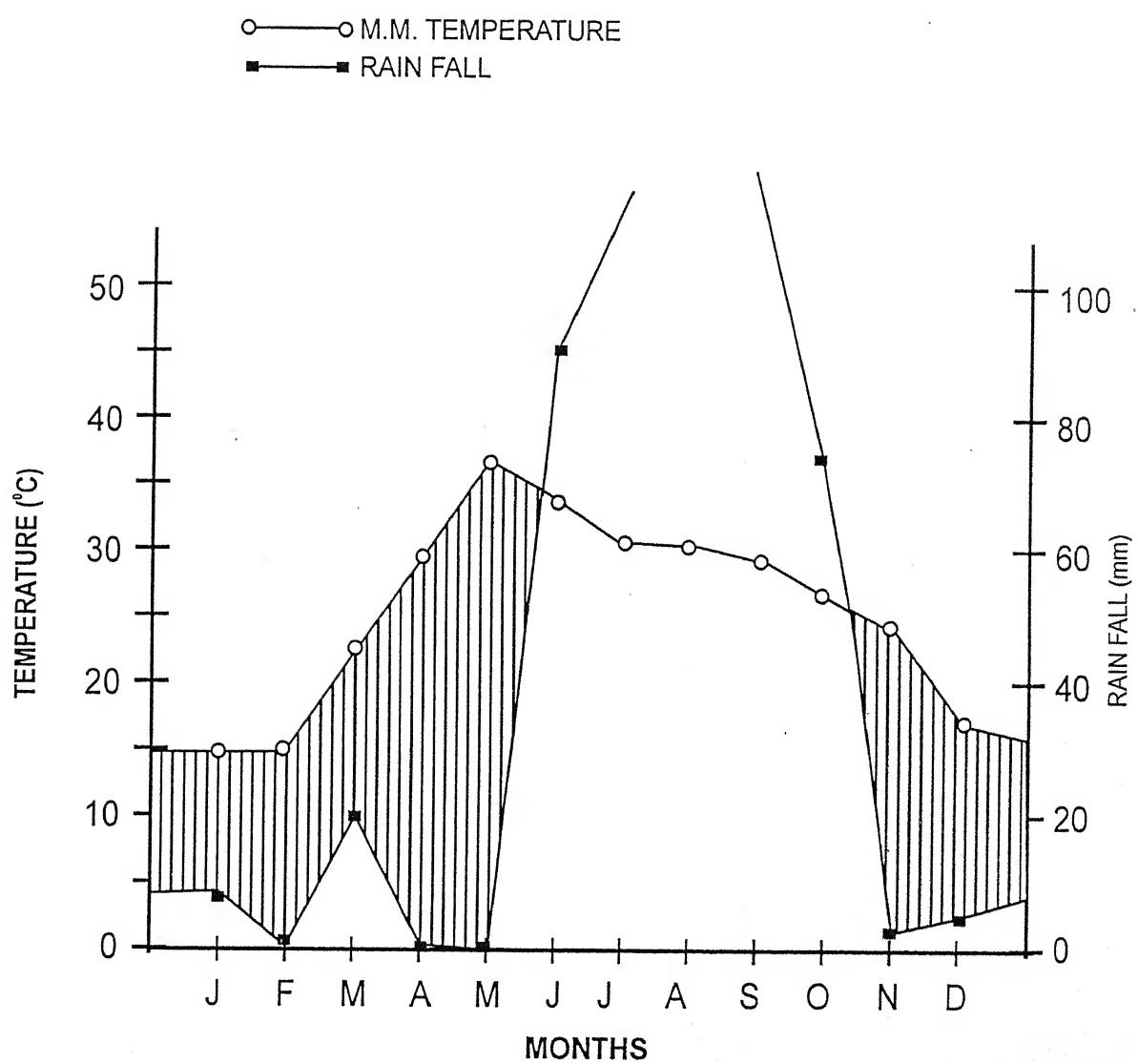


Fig. 3 : Ombothermic diagram of Orai (Jalaun)

Solar Radiation :

Solar radiation was not recorded at working sites, therefore, the mean value of Patna (Lat. $25^{\circ} 35'N$) and Jodhpur (Lat. $26^{\circ} 15'N$) stations has been considered here for calculation of total incident solar energy because the geographical situation of working sites, Orai ($25^{\circ} 59'N$) is approximately in between the above two stations.

Ecoclimate :

Climate of an area in relation to growth of vegetation is measured in the form of precipitation, wind velocity, humidity, temperature etc. Any single factor of climate does not give a clear picture about the exact climate of an area in relation to the growth of vegetation. According to Subramanyam (1958) it is not possible to say that a climate is moist or dry from precipitation alone. These measurements also do not provide the water need of a given vegetation. Water need of a given region is the total amount of water required for full use of vegetation including transpiration as well as direct evaporation from soil surface. Thus the combined evaporation from the soil surface and transpiration from plant called 'Evapo-transpiration', represents the transport of water from the earth back to the atmosphere, the reverse of precipitation. This atmospheric circulation is a part of the Hydrological cycle. The

numerical estimate of this part of Hydrological cycle in space and time leads to the concept of 'Water Balance'. Water Balance is a balance between the income of water from precipitation and the loss of water by evapo-transpiration, surface run-off and infiltration. The water balance equation after Thornthwaite is :

$$\begin{aligned} \text{Ppt} &= \text{potential evapo-transpiration} - \text{deficit} + \text{surplus} \\ &= \text{Storage change (amount of water temporarily stored in soil)} \end{aligned}$$

Potential evapo-transpiration as proposed by Thornthwaite (1948) is defined as the amount of water that would evaporate and transpire from a vegetation if soil moisture were always available in sufficient amount for optimum use. It is a climatic balance since precipitation and evapo-transpiration are active factors of climate.

On the basis of the potential evapo-transpiration (P.E.) Thornthwaite tried to obtain moisture index (I_m), from annual water surplus and water deficit. The P.E. index represents water need of a vegetation and is calculated from mean monthly temperature of the area and latitude.

The whole computation of water balance is carried on by tables and Nomograms, as proposed by Thornthwaite and Mather (1955). Subramanyam (1955 to 1959) has published a series of

papers on this aspect in India. Pandeya *et al.*, has computed the water balance of atleast 8 stations of Western India in 1973 including Jhansi station of Bundelkhand Division.

In the present study the water balance of Orai station (working sites) is computed on the above pattern as per the method proposed by Thornthwaite and Mather (1955) (table 1.3). It is evident by the table that A.E. was governed by the amount of water available for plant growth and soil moisture storage. In the rainy season, when there was sufficient water for plant growth and soil moisture storage, rates of actual evapo-transpiration were found maximum. By the end of rainy season (October) when precipitation was lesser than P.E., a decrease in the rate of A.E. was recorded and this decrease was continued till January/February. When soil moisture is at field capacity or above i.e. in the growing period (July to September) actual and potential transpiration are the same, all precipitation above the water need is counted as surplus(S). The annual value of water surplus comes to 210.5mm. This surplus water is totally spent in soil moisture recharge. When precipitation fall below the water need i.e. P.E. or actual evapotranspiration becomes less than the P.E.(October to June), this difference is the water deficit (D), the annual value is 386.4 mm. The major deficit is reported in April and May. In the graph (fig.4) monthly course of P.E. and A.E. is compared with the

Table 1.3 : Computation of Water Balance of Jalaun (Orai) 2004-2005
 Lat. N 25° 59' 30"
 Long. E 79° 37' 30"

	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Annual
T°C	29.0	28.8	27.7	26.0	23.0	16.0	14.5	14.6	22.0	29.0	35.5	32.1	
i	14.32	14.17	13.36	12.13	10.08	5.82	5.01	5.07	9.42	14.32	19.45	16.70	139.85
U.P.E.	15.54	15.38	14.53	12.0	8.0	1.4	4.5	0.6	6.4	15.54	18.37	17.35	
P.E.	182	172	148	119	73	13.0	5.0	5.3	66	165	211	198	1357.3
Ppt (mm)	615	194.8	169.7	69	3.4	5.0	8.4	2.0	19.3	1.0	0	99.2	1186.8
P-P.E.= Δ	+433	+22.8	+22.7	-50	-69.9	-8.0	+3.4	-3.3	-46.7	-164	-211	-98.8	
St	300	300	300	-254	-200	-195	-193	-191	-163	-94	-46	-33	
Δ St	+267	0	0	-46	-54	-5	-2	-2	-28	-69	-48	-33	
A.E.	182	172	148	115	57.4	10	5	4	47.3	70	48	112.2	970.9
WD.	0	0	0	4	15.6	3	0	1.3	18.7	95	163	85.8	386.4
W.S.	166	22.8	21.7	0	0	0	0	0	0	0	0	0	210.5
R.O.	83	11.4	10.85	0	0	0	0	0	0	0	0	0	105.25

T°C = Mean monthly temperature
 i = Heat index

U.P.E. = Unadjusted potential evapotranspiration
 P.E. = Potential Evapotranspiration
 Ppt = Mean Monthly precipitation
 $\sum \Delta$ = Summation Data (Potential water loss)
 S.T. = Storage
 W.D. = Deficit
 W.S. = Surplus
 R.O. = Run off
 A.E. = Actual evapotranspiration

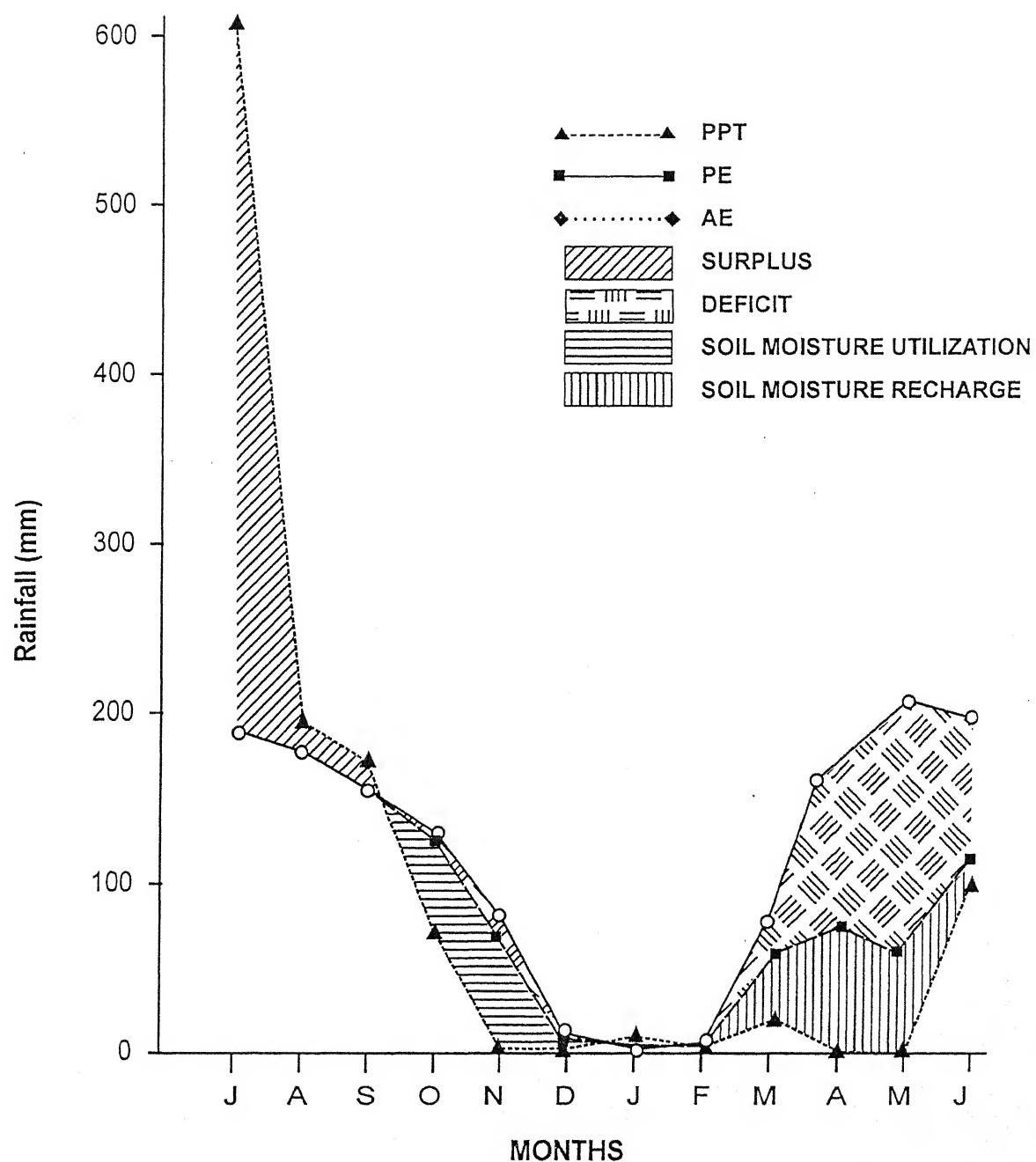


Fig. 4 : Water balance computation of Orai (Jalaun) 2004-2005

precipitation showing clearly the S and D region.

The net water surplus (S - D) for the whole year, the negative value is obtained (-17.59 cm.)

On the basis of moisture index value (-1.70) the area of the study can be classified as dry subhumid (C_1) which is further classified on the basis of thermal efficiency, i.e. P.E. (1357 mm) as second mega-thermal (A_2). The value of summer concentration of thermal efficiency (SCTE) (43.5) comes to a_2' symbol which clearly indicates that lower SCTE value means high temperature uniformly month after month. SCTE may be defined as the rates of thermal efficiency for the 3 summer months to the total annual efficiency expressed as percentage. Thus eco-climatic formula of the study area comes to $C_1 A_2' a_2'$ s. Here the small s indicate summer water deficiency.

The various climatic indices worked out are :

Potential Evapotranspiration (PE) = 135.7 cm = 1357mm.

$$\text{Humidity Index } (I_h) = \frac{S}{P_E} \times 100 = 15.5$$

$$\text{Aridity Index } (I_a) = \frac{D}{P_E} \times 100 = 28.46$$

$$\text{Moisture Index } (I_m) = I_h - 0.6 \times I_a = -1.70$$

$$\text{Summer Concentration of Thermal Efficiency (SCTE)} = 043.5$$

Total annual precipitation is 1186.8mm and because of large amount of radiant energy received (table 1.2), the P.E. is always higher than the precipitation (Ppt), except in the month of July, August and September and to some extent in January, when it almost compensates each other.

Description of sites :

During present investigation the different sites for selected medicinal plant species are shown in table 1.4. Phenological study and plant and seed collection of selected plant species viz. *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens* was done from in and around Jalaun district from following sites.

1. Orai Site -

It is situated about 22 km on Jalaun-Orai road. It is composed of basalt rocks. The vegetation is ecologically degraded. The bushy and thorny habit of trees are common in this region.

2. Konch Site -

It is situated about 20 km in west direction of Jalaun on Jalaun-Konch road. This site is characterized by good agricultural land. The natural vegetation is same as described earlier.

3. Kalpi Site -

This site is situated on the way of Jalaun to Kalpi road via Orai. It is about 55 km from Jalaun. The vegetation is almost the same as in Orai with more thorny and scrubby plant habits.

4. Jalaun Site -

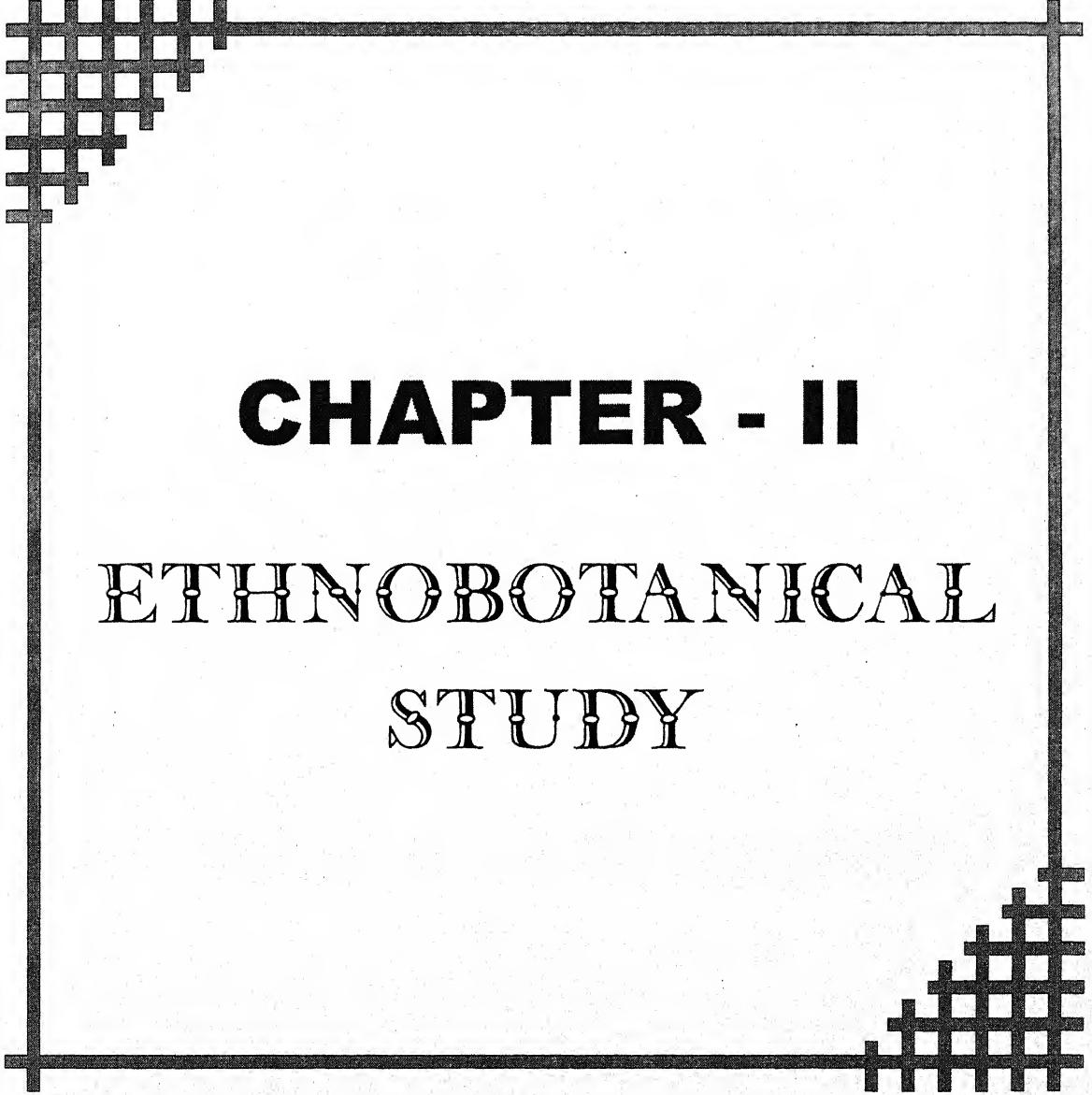
It is situated in north direction of Orai at about 22 km on Orai-Jalaun road. Topography of the site is undulating with rounded basalt boulders on the surface. The forest in patches are open and degraded.

Table 1.4 : Different sites showing the selected medicinal plant species

Sl.No.	Botanical Name	Habitat	Site I	Site II	Site III	Site IV
1.	<i>Argemone mexicana</i>	A common weed on waste land	+nt	+nt	+nt	+nt
2.	<i>Boerhaavia diffussa</i>	An abundant weed on grassy and stony lands	+nt	+nt	+nt	+nt
3.	<i>Casia obtusifolia</i>	A very common weed all over the area by road sides and in waste ground	+nt	+nt	+nt	+nt
4.	<i>Datura metel</i>	Near habitations and religious places like temple etc.	+nt	+nt	-	-
5.	<i>Tridax procumbens</i>	Abundant within the area by road sides in grassy places and on old walls	+nt	+nt	+nt	+nt

+nt = Present

- = Absent



CHAPTER - II

ETHNOBOTANICAL STUDY

ETHNOBOTANICAL STUDY

INTRODUCTION

The relation of man with its surrounding vegetation is age old and the use of plants for his multipurpose need back to centuries. Because of sheer necessity, man has been using plants and their products for food, clothing, shelter and above all for alleviating diseases. The curative properties of plants, learnt by ancient people, perhaps after several attempts of trial and error, empirical reasoning and even by experimentation and observations have become part of the ethno medicinal traditions. All ancient cultures of the world have evolved their own medicinal lores and practices to take care of their health problems. Such health care practices were all culturally, socially and environmentally closer to the masses and were systematically recorded and incorporated into pharmacopoeias of many eastern cultures like Indian, Chinese and Arabian that later became the *materica-medica* of the medicine.

Tribal people are mostly living in and around the forest and they are closely associated with their biotic surroundings. They depend on forest to some extent for their survival. They possess empiric knowledge about their biotic surroundings, which is

going to vanish due to less knowledgeable survivors.

The term 'Ethnobotany' has been used currently to define the medicinal uses of plants in relation to human beings. In other words we can say that ethnomedicine is the ethnobotany of medicinal plants. 'Ethnomedicine' gives the initial medicinal information about a particular plant.

The discovery of the curative properties of plant is age-old. People had been making use of plants, for their beneficial and curative effect, long before scientific explanation were available. The curative effect of medicinal plants could have been gathered by ancient people, perhaps after several experiences and they identified some of them by the result they induced. They observed critically which plant should be taken in a particular disease. These findings, later on gave rise to the traditional system of medicine in various ancient traditions of the world. Indian system of medicine has a rich tradition with outstanding information about medicinal plants and utility of the ideas and is found to be a great relevance even today. The validity and utility of the ideas and concepts which have been suggested in ancient tradition several thousand years ago, need to be scientifically tested and explained for their worldwide acceptance.

India's ancient culture contained a veritable mine of health care with outstanding information about medicinal plants.

Ayurveda, the oldest recorded system of medicine in India is concerned with the principles of health and attaining long healthy life. 'Charak-samhita', the oldest medicinal treatise of the country, is a veritable store house of medicinal plants. Various systems like Ayurveda, Unani, Tibetan and Homeopathy have been utilizing plants for their respective preparations in the treatment of human suffering and have now assumed a great importance owing to the side effects of synthetic drugs. The tribal and other ethnic communities in different parts of India continue to depend on traditional plants for relief from illness and suffering and they have elaborated their own traditional herbal cure. However, many of these cures are often kept as guarded secrets and passed on from generation to generation. Hence, it is important to discover this hidden and secret treasure of the flora.

The people of rural India, by and large are still dependent on traditional medicines for their healthcare and treatment of diseases. These medicines have been developed through the experience of many generations assimilating the knowledge, in course of time, from fragments of Ayurvedic, Unani as well as tribal systems of medicine. These may be called 'Folk Medicines'.

".....Jagatyevam anaushadham na kinchit vidyata
dravyam vashaannartha yogayoh...."

There is nothing in this universe, which is non-medicinal, which cannot be made use of for many purpose and by many modes.

The most complete modern definition of ethonobotany is the study of direct interaction between human beings and plants; the study concentrated with the totally of the place of plants in culture (Ford, 1978).

“Medicine” is any substance that can bring about a change, anywhere, anyhow. “Medicines” had a sickness catch a thief, help someone to pass an exam., make a business prosper, kill an enemy and win someone’s love”.

“Popular knowledge is the most valuable part of the medical tradition. It needs to be safe guarded and strengthened if we want to enhance people’s ability to cope with health problem and to improve the quality of health care”.

India has one of the oldest, richest and most diverse cultural traditions associated with the use of medicinal plants – still a living tradition as borne out by the fact that there still exist around a million traditional village based servers of herbal medicinal traditions in the form of traditional birth ailments, bone-setters, herbal healers and wandering monks alongside village elders having

traditional knowledge of herbal home remedies and of food and nutrition.

'Ethnomedicine' is an important aspect of ethnobotany. 'Ethnobotany' commonly refers to the interrelationship between primitive people and plants in its natural environment.

The primitive man used raw materials and raw extracts of plants to alleviate sickness and ailments without the scientific knowledge of their active ingredients.

Plants have been used as a source of drug by mankind for centuries. The ancient man was totally dependent on plants to fulfil his day to day requirements for food, shelters, clothing and medicament. He has his own ways of selection and use of the medicinal and economic plant species through trial and error methods and has derived almost all his medicinal products from the plants. His method of using these plants and their products in medicine was very natural and not destructive to the nature. He discovered a large number of plant species useful in ancient traditional systems of medicine. The present day knowledge about medicines is considered to be a gift of ancient man and even today the traditional systems of medicine are being practiced widely in Asia, Africa and Latin America (Kapoor, 1993).

Advancement of science and medicine have developed an unprecedented pressure on the limited natural resources during the present century.

The term ‘Ethnobotany’ was first used by Harshburger (1895) and its scope was much elaborated later (Ford 1978; Foulks, 1958). Since then there has been a growing interest in this field (Jain 1986; Martin 1995).

Jain (1989) described ethnobotany as “the total natural and traditional relationship and interaction between man and his surrounding environment.

A National Biodiversity Act is also on the anvil in response to our commitments to the Convention on Biological Diversity (CBD). The CBD has advanced beyond the conventional intellectual property rights regime to accept the sovereign rights of nations over their biodiversity resources, and the need to share benefits of commercial application of traditional knowledge sustainable uses of biodiversity resources with local communities.

MATERIALS AND METHODS

Following aspects are taken for morphological and ethnomedicinal studies of selected medicinal plant species.

- (i) Plant Collection

- (ii) Herbarium
- (iii) Identification
- (iv) Data Information

Plant Collection :

Collection of plant was carried out from 2004 to 2005 in different villages and forests of Jalaun region. Selected study sites of Jalaun region were visited for the collection of plants. The selected sites were visited in each season of the year. The field work and periodic collection of plants was conducted.

Collection of plants was done under following steps :

- * Seasonal trips to the region were made for obtaining the complete specimen, flowering stage and fruiting stage.
- * Essential equipments were used during collection of plants.
- * Proper field notes for each species were recorded giving botanical name, local name, locality, habit and general morphology of plants.
- * Collected specimens were pressed properly for drying in such a manner that as far as possible, all the features of the plant remained visible. Collected specimens were brought to laboratory for further processing.

The word 'Hebarium' in its original sense referred to a book on medicinal plants. It was only in the beginning of the 18th century the term herbarium was first used for a collection of dried plants. The modern day herbarium is a store-house of processed and dried plant specimens collected from far and wide mounted on standard size sheets, arranged according to some known system of classification and kept in steel pigeon hole or wooden cup-boards. FRLHT, a pioneer in the conservation of medicinal plants in South India, set up a medicinal plants herbarium in early 1993, as a part of its conservation programme.

Preparation of herbarium specimen is very necessary for an ethnobotanist. Herbarium contains 'data-bank of plant'.

Herbarium :

The herbarium database has four features :

- (1) **Voucher Specimen** : Gives details of collection site, date of collection, local names, local use, biotic association, special remarks and collector's name.
- (2) **Location Details** : Gives information regarding the site from which the plant specimen was collected, its latitude, longitude and altitude, taluk, district, state, forest name type and its status (distributed and undistributed), soil type, colour, texture and soil depth of the site.

(3) **TAXON DETAILS** : Gives information regarding the species, family, variety etc. red list status, the medicinal system which has reference of use and synonym linkage.

(4) **Morphological Details** : Deals with the habit and phenology. Other information like the micro habitat, frequency of occurrence and regeneration status of a particular species are accessible from this herbarium database.

These collected plant materials were than critically studied and identified in laboratory by consulting available literature.

The herbarium is also collecting photos of plants and of the parts used as medicine.

1. *Argemone mexicana* (Linn.)

Family - Papaveraceae

Local Name : Pili Katari, Pivala Dhotra, Satyanashi

Study Region : Orai, Jalaun, Konch, Kalpi

Habit : A pickly herb, a height of 1-2 ft., wild plant, annual.

Leaf : Leaves sessile, 1/2 amplexicaul, sinuate pinnatified, 3-7 in long, toothed.

Flower : Yellow or rarely white coloured, 2.5-5 cm dia., solitary and sessile or subsessile.

Fruit : Capsule, prickly, oblong-ovoid, 2.5-3.8 cm. opening by 4-6 valves, dehiscing at the top by short valves.

Plant Part Used in Medicine : Seeds, roots, stem, leaves.

Medicinal Uses :

1. Seeds are pounded with water and the paste is applied on skin disease.
2. The latex is applied in scabies.
3. The whole plant is boiled in water and used for taking bath.
4. The whole plant excluding roots made into fine paste and applied on white patches in lips and body.
5. Single plant paste applied on whole body for eczema.
6. The root is used in stimulant.
7. The root juice is used as a collyrium cures othalmia and opacities of the cornea.
8. The root is beneficial in some chronic cases of skin diseases.
9. Leaves are used for coughs and asthma.
10. The smoke of the seeds is used for toothache.
11. The yellow juice of this plant is used for dropsy, jaundice excoriations and indolent ulcers.

12. The juice with milk is given in leprosy.

13. Stem is considered diuretic.

2. *Boerhaavia diffusa* (Linn.)

Family : Nyctaginaceae

Local Name : Punarnawa, Pachakeera

Study Region : Orai, Jalaun, Konch, Kalpi

Habit : A diffusely branched herb, 1-2 ft. long.

Leaf : Thick, opposite, often unequal in pairs,
 $\frac{1}{2}$ - $1\frac{1}{2}$ in. long, ovate, oblong or
suborbiculate, glabrous, subundulate.

Flower : Minute, subcapitate, 4-10 together in small
bracteolate umbels forming slender long
stalked axillary and terminal panicles.

Fruit : 1/8 in. long, clavate, rounded, viscidly,
glandular on the 5 broad blunt ribs.

Seed : Single, ovate, brownish-black in colour.

Plant Parts Used in Medicine : Roots, leaves, seeds.

Medicinal Uses :

1. According to Ayurveda, Punarnawa is bitter, cooling,
astringent to bowels, useful in biliousness, blood impurities,
leucorrhoea, anaemia, inflammations, heart diseases, asthma,
alternatives etc.

2. According to Unani system of medicine the leaves are appetizer, useful in ophthalmia, in joint pains.
3. The leaves are useful in dyspepsia, tumours, spleen enlargement, abdominal pains.
4. The seeds are useful in lumbago, scabies.
5. The seeds also considered as promising blood purifier.

3. *Cassia obtusifolia* (Linn.)

Family : Caesalpiniaceae

Local Name : Panwar, Pumar, Chakunda, Chhoti kasondi

Study Region : Orai, Jalaun, Konch, Kalpi

Habit : Annual herb, wild, 30-90 cm height

Leaf : Pinnately compound, membranous, glaucous, rachis grooved with a conical gland between each of the two lowest pairs of leaflet, leaflet 3 pairs, opposite, ovate-oblong.

Flower : Yellow, subsessile, pairs in the axils of the leaves, the upper crowded.

Fruit : Pods, 12.5-20 cm long, subtetragonal, obliquely septate, puberulous.

Plant parts used in medicine : Leaves, seeds.

Medicinal Uses :

1. The pods are used in dysentery and in diseases of the eye (in Indo-China)
2. The leaves are given to children with intestinal troubles.
3. The leaves and seeds are useful in ringworm, leprosy, disorders and haemorrhoids.
4. Leaves and seeds are also used in hepatopathy, constipation, colic, dyspepsia, ophthalmopathy.
5. In central India- Young seedling eaten for easy delivery.
6. In Orissa- seed and haldi taken in equal part and applied as poultice in gonorrhoea.
7. In Nigeria- a poultice of the leaves applied to boils for suppression.
8. Leaf and root powder is used for skin diseases like ringworm, scabies and eczema.

4. *Datura metel* (Linn.)

Family : Solanaceae

Local Name : Kala Dhatura, Kurchatta, Shiv-phul

Study Region : Orai, Jalaun

Habit : Annual herb or shrub, 0.9-1.2m height, stout, erect.

Leaf : Triangular, 15-20 cm long, ovate, lanceolate or cordate, entire or dentate, glandular.

Flower : Solitary, large, purplish outside and white inside, tubular, funnel shaped.

Fruit : Capsule, globular, covered all over with numerous fleshy prickles.

Seed : Numerous, smooth, yellowish brown

Plant part used in medicine : Whole plant

Medicinal Uses :

1. The seeds are used in bites of mad dogs, purulent discharges from the ear, elephantiasis, indigestion.
2. The roots of *Datura metel* is boiled in milk and this milk is administered with clarified butter and treacle in insanity.
3. The seeds, leaves and roots are considered useful in insanity, fever, with catarrhal and cerebral complications, diarrhoea, skin diseases, lice etc.
4. The flowers are used in asthma and the fruits in earache.
5. The pounded leaves are applied to swellings, tumours and rheumatic pains.

6. A decoction of the seeds is used for diseases of the age.
7. The juice of the leaves is used for epilepsy, caphalgia.
8. A poultice made out of the leaves is used for ophthalmodynia, otalgia, lumbago, neuralgia, mumps and painful swellings.
9. Mundas put seed paste as cure for toothache.
10. Dried seed powder is used for the treatment of hydrophobia.
11. Ripe seeds are used for the treatment of asthama.
12. Seeds are used for antifertility and abortion.

5. Tridax procumbens (Linn.)

Family : Asteraceae

Local Name : Dimajari, Ghamra, Phooli, Kambarmodi,
Coat buttons

Study Region : Orai, Jalaun, Konch, Kalpi

Habit : A weak straggling pubescent or hispid herbs,
1-2 ft. height, perennial.

Leaf : Simple, few, petioled, 1-2 in. long, ovate or
lanceolate, dentate or pinnatisect, clothed on
both sides with bulbous based hairs.

Flower : Ray flowers yellow, 3- partite, peduncles

aften more than one foot long, solitary,
selender, sparsely pilose.

Fruit : Achenes, 1/12 in. long

Seeds : Brown with pappus of many shining feathery
bristles.

Plant Part Used in Medicine : Leaves, roots, seed.

Medicinal Uses :

1. Paste of leaves is applied on cuts and wounds to stop bleeding.
2. Leaves are chewed in toothache.
3. Lodha woman uses a piece of root for causing abortion upto 3-4 months of pregnancy.
4. Leaves juice used as ear drops to relieve ache and in stones or hemicrania.

REVIEW OF LITERATURE

Plants have formed the basis for traditional medicine systems, which have been used for thousands of years in countries such as China and India. The use of plants in the traditional medicine systems of many other cultures has been extensively

documented. These plants-based systems continue to play an essential role in health care, and it has been estimated by the World Health Organisation that approximately 80% of the world's inhabitant rely mainly on traditional medicines for their primary health care. Plant products also play an important role in the health care systems of the remaining 20% of the population, mainly residing in developed countries. Pharmacies in the United States from 1959 to 1980 indicates that about 25% contained plant extracts were derived from higher plants, and at least 119 chemical substances, derived from 90 plant species, can be considered as important drugs currently in use in one or more countries. Of these 119 drugs, 74 were discovered as a result of chemical studies directed at the isolation of the active substances from plant used in traditional medicine.

The history of the use of plants in medicine can be traced back to the ancient civilization or pre-Rig Vedic times. The earliest written record of the preparation and use of medicines from plants is in the Rig-Veda, the earliest Sanskrit scripture of the Hindus (4500-1600 BC) having mentioned about 99 medicinal plants. The Atharveda is another important treatise, which deals with about 288 plants used in medicine and is supposed to be the most important literature on medicinal plants of ancient times. In the Yujurveda, only 82 plants have been described whereas in the Kalpa

Sutras, 519 plants having medicinal properties are mentioned. There is no information on the development of this science in India for about 1000 years due to historical reasons. Then appeared the two most important works in Indian system of medicine namely the Charak Samhita (1000 BC) and Susruta Samhita (800 BC).

Compilation on Indian medicinal plants started in the early 19th century. The earliest contributions are by Sir William Jone - 'Botanical Observations on Selected Plants' (1799) followed by Johan Fleming's Catalogue of Medicinal Plants (1810), Ainslie's Materia Medica of Hindoostan' (1813, 1826), Roxburgh's flora Indica' (1820-1832) and Royle's An Essay on the Antiquity of Hindu Medicine' (1837). O'Shaughnessy's The Bengal Dispensatory' (1841) is the first book dealing exclusively with the properties and use of medicinal plants.

The systematic study of Indian medicinal plants was started in the beginning by Chakravarty (1975). In recent years much work in the science has been done in a number of countries such as USA, England, China, France, Mexico, India etc. An introduction of ethnobotany by Faulks (1958) is the first book on ethnobotany of present world. It described plant for food, medicine, drinks, weapons, rituals etc. In the beginning of 19th century researcher in India began the reclassification and rearrangement of old Ayurvedic texts and compiled their works in various ways. Every

method of classification has rendered some help in the progress of the drug science. Sarmah (1968-69) has listed about 248 botanical drugs from Atharveda and Rigveda itself.

The important contributions on Indian medicinal plants in 20th century included (Chopra, 1933) 'Indigenous Drugs of India', Indian Materia Medica (Nadkarni, 1926), Bhartiya Banaushad (Biswas & Ghosh, 1950-1952), A Review of Indian Medicinal Plant (Chopra & Chopra 1955) and Chopra's Indigenous Drugs of India (Chopra *et al.* 1958). More recent work like medicinal plants of India (Satyavati *et al.* 1976) and Cultivation and Utilization of Medicinal Plants (Atal & Kapur 1982), Medicinal Plants (Jain 1985) and a large number of research papers added to the wealth of literature on Indian Medicinal Plants. The study included ancient and recent literature like Sharma (1968-69) who enlisted 248 botanical drugs which are mentioned mainly in Atharvaveda and Rigveda. Singh and Chunekar (1972) published a glossary of such medicinal plants. In a recent work, Jain & De Flripps (1991) have briefly described about 1850 species of Indian Medicinal Plants.

The first ever published document of Indian Medicinal plants is by Kirtikar and Basu (1918). The authors were army officers, who travelled in different parts of India and collected first hand information about the medicinal plants. The book which is in 4

volmes was revised in 1933 and also was republished due to its great demand.

After Independence, the Government of India established various departments to carry out researches in the field of Indian system of medicine and many important publications appeared during this period. The important contributions on Indian Medicinal Plants after Independence include Datta and Mukherjee (1950-52), Chopra *et al.* (1956), Mitra and Jain (1991), Sivrajan and Balachandran (1994), Raychaudhuri (1995), Tripathi (1995) and Kaushik and Dhiman (2000). The important work on medicinal plants of Garhwal Himalaya includes Saha (1975), Joshi *et al.* (1982), Badoni (1989, 1995), Kumar and Rohatgi (1996), Prahar and Biswas (1998), Rana *et al.* (1988), Mohideen and Sekar (1999). Besides these mentions have been made about medicinal plants in floras of the region published by various workers like Duthie (1906), Babu (1977), Raizada and Saxena (1978), Gupta (1981), Gaur (1982, 1987), Naithani (1984), Balapure (1985), Pant (1986), Silas and Gaur (1987), Rajwar and Gupta (1988), Bartwal (1991) and Gaur (1999).

The other contributions on ethnobotany included various workers like Badoni (1986, 1989, 1995), Bist *et al.* (1988), Negi and Pant (1990), Sarin (1990), Ansari (1991), Negi *et al.* (1993), Datta and Lal (1994), Pal (2000) and Badoni (2001).

According to Iyengar (1988), India ranked second after South Korea in the supply of Medicinal plants to developed countries. During 1963-64, the value of exports was Rs. 36.3 million, it increased to Rs. 314 million in 1974-75.

During the five years periods 1976-77 to 1988-81, exports of ten drugs- *Atropa belladonna* (Balladonna leaves, roots), *Swertia chirata* (Chirata), *Alpinia officinarum* (Galangal rhizome, root), *Plantago psyllium* (Psyllium husk, seed), *Glycyrrhiza glabra* (Liquorice), *Strychnos colubrina* (Nux-vomica seed), *Cassia angustifolia* (Senna leaves, pods), *Rauvolfia serpentina* and *Curcuma zedoaria* (Zedoary roots) - were 69 million kg of gross value of Rs. 690 million.

India occupies a position of virtual monopoly in respect of exports of *Papaver somniferum* (Opium) 'Isabgol', *Saussurea costus* (Kuth roots) and Senna leaves and pods.

Borthakur (1993) has reported thirteen native plant remedies for child diseases and 21 for women diseases present among the different group of Assam. The virgin field of Psychoactive plant research by Schultes (1993), Brahman and Saxena (1990), Oomach and Masih (1987, 1991), Park (1993) and large numbers of research papers have added to the wealth of literature on Indian Medicinal Plants.

Medicinal uses of plants by Kondh tribe of district Phulbani (Orissa) has been imphasized by Udaygiri (1992). The paper enumerates 40 plants used for making colours utilized in mithila paintings, 10 plants extracts added as fixatives to the colours and 14 plants symbolizing fertility, potency, good women and reverence to deities in these paintings.

A brief account of ethnomedicinal plants of Victoria Park, Bhavnagar is presented by Bhatt and Mitaliya (1999). Forty four species which are commonly used by tribals and rural population are enumerated.

The ethnobotanical observations carried out on the Lepchas of Sikkim show that 141 plant species are being used by the Lepchas of Dzongu for various purposes in their daily life e.g. wild edibles, dye, fibre, fish poisoning, aromatic, fodder, timber and folk medicine.

Sagar region of Madhya Pradesh is rich in medicinal plants and is inhabited by various tribes and other people secluded from urbanization and from the impact of modern technological developments, provide good scope for ethnomedicinal studies. Only a few preliminary reports on ethnomedicinal aspects of this region are available (Bhalla *et al.*, 1982; Sahu, 1982; Sahu *et al.*, 1983; Malaiya, 1992; Dixit, 1994). Like Sagar region, Bundelkhand region

of Uttar Pradesh is also rich in medicinal plants. Hence a survey of various localities of Jalaun was carried out for the collection of plants and informations regarding medicinal plants and their ethnomedicinal uses with the help of personal interview with rural people, old villagers, vaidyas, local traditional doctors and from the available literature.

Present status of medicinal plants in any region is an important aspect for the study of ethnomedicine because the rate of exploitation of such species is very fast. In some sites of Jalaun district, certain medicinal species are being collected and exploited by petty contractors through labourers or by native people and others. These collected plants are supplied to many herbal drug companies. Due to rapid exploitation, such species are nearing the threshold of endangered stage. Hence in this work the present status of medicinal species in different sites of Jalaun have also been observed.

Simultaneously, Valuable works were published e.g. 'Indian-Materia-Medica' by Nadkarni (1926), 'Indigenous drugs of India' by Chopra (1933), 'Bharatiya-Banaushadhi' by Biswas and Ghosh (1950-1952), 'Indian Pharmaceutical Codex' by Mukherjee (1953), Monographs on 'Pharmacognosy of Root & Rhizome drugs' and 'Pharmacognosy of leaf drugs' by Dutta and Mukerji (1950-1952); 'A review of Indian Medicinal Plants' by Chopra and Chopra

(1955), 'Glossary of Indian Medicinal Plants' by Chopra *et al.* (1956) and the 'Indigenous drugs of India' by Chopra *et al.* (1958).

Ethnomedicinal studies of certain ethnically distinct primitive or otherwise interesting human societies have been done e.g. on the Mikir of Assam by Jain and Borthakur (1980), on Bhils of Rajasthan by Joshi (1982), on Tharus of Uttar Pradesh by Maheshwari *et al.* (1980) and on Abujhmarea tribe of Bastar (M.P.) by Maheshwari and Dwivedi (1985).

Ethnomedicinal studies of plants which are used in particular diseases like on rheumatism by Hemadri (1991), on diarrhoea and dysentery of Sahu (1982, 1983), on contraceptive herbs of Billore and Audichya (1978), on child birth to child care by Joshi (1989), on antidiabetic plants of Upadhyay *et al.* (1996) and on plants which used against snake bite by Raju (1966).

Ethnomedicinal studies of a particular plant, genus or family of plants have been done e.g. on *Bauhinia* by Jain *et al.* (1973), on *Selaginella* by Dixit (1982), on *Cissus quadrangularis* by Kumbhojkar *et al.* (1991) and on *Zingibers* by Jain (1995). Mishra (1998) has studied 150 species of medicinal plants of Sagar region. Yadav (2002) has also studied seven species of medicinal plants of Sagar region.

Khan and Shukla (2000) have described some ethnomedicinal plant species belonging to 49 genera and 34 families of angiosperms. Brahman (2000) discussed besides enumerating some of the important drugs developed recently by taking leads from tribal uses of plant. Study of some medicinal plants of Darjeeling hills, and their Silvicultural practices were done by Saini (2000).

Estimates place the Charak-Samhita in its present form as dating from the 1st century AD, although there were earlier version. The Susruta-Samhita probably originated in the last centuries BC and had became fixed in its present form by the 7th century AD, of somewhat lesser importance are the treatises attributes to Vaghbata. All later writings on Indian medicine were based on these work.

Because Hindus were prohibited by their religion from cutting the dead body, their knowledge of anatomy was limited. The Susruta-Samhita recommends that a body be placed in a basket and sunk in a river for seven days. On its removal the parts could be easily separated without cutting. As a result of these crude methods, the emphasis in Hindu anatomy was given first to the bones and then to the muscles, ligaments and joints. The nerves, blood vessels and internal organs were very imperfectly known.

The India, *materia medica* was extensive and consisted mainly of vegetable drugs, all of which were from indigenous plants. Charak knew 500 medicinal plants, and Susruta knew 760. But remedies and minerals were also employed.

Indian medicine has a long history. Its earliest concepts are set out in the sacred writings called the Vedas, especially in the metrical passages of the Atharvaveda, which may possibly date as far back as the 2nd millennium B.C. According to a later writer, the system of medicine called Ayurveda was received by a certain Dhanvantari from Brahma, and Dhanvantari was defined as the god of medicine. In later times his status was gradually reduced, until he was credited with having been an earthly king who died of snake-bite.

The period of Vedic medicine lasted until about 800 B.C. The vedas are rich in magical practices for the treatment of diseases and in charms for the explosion of the demons traditionally supposed to cause diseases. The chief conditions mentioned are fever (takman), cough, consumption, diarrhoea, dropsy, abscesses, seizures, tumours, and skin diseases (including leprosy). The herbs recommended for treatment are numerous.

The Golden age of Indian medicine, from 800 B.C. until about A.D. 1000, was marked especially by the production of the

medicinal treatises known as the Charak -Samhita and Susruta-Samhita, attributed respectively to Charak , a physician and Susruta, a surgeon.

As a result of the strict religious beliefs of the Hindus, hygienic measures were important in treatment. Two meals a day were decreed, with indications of the nature of the diet, the amount of water to be drunk before and after the meal, and the use of condiments, bathing and care of skin cleaning of teeth with twigs from named trees, anointing of the body with oil, and the use of eye washes.

AN INTRODUCTION OF INDIAN SYSTEM OF MEDICINE

1. Ayurveda : A system of medicine

Human life and knowledge of preserving it as a going concern, in the face of overpowering and brute physical and biological environment, must have come into being almost simultaneously. It has to be so. There cannot be any other plausible explanation, other than this, to account for the continuity of human race and survival of its several highly developed culture and civilization. All known culture of the past Egyptian, Babylonian, Jewish, Greek, Indus-valley etc. had their own equally glorious and useful systems of medicine and health care.

The philosophy of Auryveda is based on Panchmahabutas, of which the body is composed of Charak Samhita and Susruta Samhita are the basic classics of Auryveda written during 5th century B.C. Healthy person is one in whom there is equilibrium of the humours and body tissues, with normal digestive as well as excretory functions, which are responsible to gratification of physical senses and mental as well as spiritual forces. Absence of this equilibrium describes the status of diseases or sickness.

The mental-spiritual forces are described as **Sattva**, **Rajas** and **Tamas**. Predominance of **Sattva** characterises a man of pure and clear thought and ideas. Dominance of **Rajas** imply that the person is full of activity and energy. **Tamas** is the quality indicating that the man is passive and ignorant. For a man to be healthy it is also necessary that there is functional equilibrium among these three components. Loss of this equilibrium describes a sick status.

Like mind, in case of physical body or sense also, there are three components of **Vata**, **Pitta** and **Kapha**. These are known as three humours. In a healty person these are in functional equilibrium, and loss of it leads to sickness. These three conditions, describing presence or absence of functional equilibrium, also define the status of being healthy or sick respectively.

In India, development and growth of such a body of knowledge known as Ayurveda, meaning science of life, was coeval with the growth and evaluation of Indian civilization and culture. Vedas, which are considered to be the repositories of recorded Indian culture, have mention of this knowledge both in theoretical and practical form. There is discussion of theories about the composition of living and non-living matter, the physical, biochemical, biological, psychological and spiritual components of man and the vital motive forces working both inside and outside the body. In other ancient works there is mention of such current medical subject like anatomy, physiology aetiology, pathology, treatment and environmental factors. This medical knowledge has been the work of ages. It is the out-come of the great power of observation, generalisation and analysis combined with patient labour of hundred of investigators spread over thousand of years. This knowledge has played so important part in the development of Indian culture that it has been documented in an integrated form in the Vedas which are considered to have been originated from Gods. Most of this mythological and medico-religious genesis of Ayurveda is even today shrouded in the mist of antiquity.

Systematic Research in Ayurveda under the patronage of Govt. of India started in 1969 with the establishment of Central Council for Research in Indian Medicine and Homoeopathy. In the

year 1978 CCRIMH was split into Ffour separate Councils one each for Ayurveda & Siddha, Unani Medicine, Yoga & Naturopathy and Homoeopathy. The Central Council for Research in Ayurveda & Siddha (CCRAS), an Autonomous Organisation under Ministry of Health & Family Welfare, Govt. of India is engaged in developing independent and multi-dimensional Research into various fundamental and applied aspects of Auryveda.

2. Unani : A System of Medicine

Unani System of Medicine originated in Greece. It was further enriched and developed in Arabs and Persians. Hippocrates explained that the disease was a normal process and its symptoms were the reaction of the body to the disease. The chief function of the physician was to aid the natural forces of the body. He held that there exists in the body 4 humours that keep up the balance of it. He also laid emphasis on diet and drugs of plant, animal and mineral origin for cure of the disease.

A galaxy of Unani Medical Luminaries have come to the forefront after Hippocrates, Aristotle, Herophillus, Erasistratus, Ibn Sina, Diascoridee, Galen, Al-Mamum Ibn Massawayh, Rhazée, Ibn Ishaq, Ibn Al Baitar *et al.* have contributed a lot to this system of medicine. Aristotle's study on anatomy and embryology, Galen's on the value of anatomy and experimental physiology, Ibn Massawayh's

book on dietetics drugs, fever, stomach disorder, catarrh, diarrhoea, colic and alchemy and Avicenne's Medical Book 'Canon' are the bright examples of the development of Unani System of Medicine. The most esteemed of Rhaze's medical works 'Al-Hawi' was an Encyclopedia of Unani Tibb. He had written some important books like Al-Kitabul Mansuri and Treatise on small pox and measles. Apart from the eminent scholars the most renowned physician of all the time was Ibn Sina (*Avi cenna*) (900-1037 AD) an eminent physician, philosopher, scientist, statesman and poet who have kept this system of medicine alive for all times to come.

Three eminent bright scientists and scholars of India during this century have contributed their expertise and skills for all time to come cannot be ignored. Of them one research scholar was Hakim Ajmal Khan, who had established the famous institutes of Ayurveda and Unani in one campus in 1921 in Delhi. In his span of a very short period he produced a Unani drug from *Rauvolfia serpentina* for the cure in hyper tension and in mental disorder after extensive research. Some active ingredients like Ajmalin and Ajmalinine are named after him. The second research scholar was Hakim Kabirudin Saheb, for whom we owe unconditional thanks for Unani system for its existence in India. Hakim Kabirudin Saheb has translated all the classical books of Unani system from Arabic to Urdu. This system is alive due to his sincere efforts and

contribution. The third expert in Unani medicine was Hakim Abdul Razaque, who has established Central Council for Research in Unani Medicine a pioneer institute in 1969 in India to undertake research in Unani Medicines.

Systematic Research in various Indian Systems of Medicine including Unani Medicine under the patronage of Government of India started in 1969 with the establishment of Central Council for Research in Indian Medicine and Homoeopathy (CCRIM & H). In the year 1978, CCRIM & H was split into four separate Councils one each for Auryveda & Siddha, Unani Medicine, Homoeopathy, Yoga and Naturopathy, The Central Council for Research in Unani Medicine (CCRUM), an autonomous organisation under the Ministry of Health and Family Welfare, Government of India engaged in developing independent and multi-dimensional research into various fundamental and applied aspects of Unani System of Medicine. The CCRUM gained name and fame for the successful treatment in Leucoderma during its thirty years of research

3. Siddha : A System of Medicine

Siddha is one of the ancient medical systems of the World. It was founded by Siddhars (Saints) who were highly talented Scientists and who perfectly understood the human mind

and body during health and illness from embryonic life to death. The founders, who were known as Siddhars, lived in various parts of India, in general and Southern India in particular, specially around Tamil Nadu. This system of Medicine developed within the Dravidian Culture which is of the pre-vedic period. The Siddha System is largely therapeutic in nature.

The medical literatures of Siddha which are mostly in the form of cudjan leaves in Tamil language and scientifically and systematically codified into various subjects starting from embryology paediatrics to Geriatrics including the intermediary subjects like Ophthalmology, Gynaecology etc. This is the only system which deals leprosy under separate topic. This system also deals with the concept of salvation of life. The exponents of this system consider achievement of this state is possible by medicines and meditation.

Government of India has set up a Pharmacopoeia Committee for Siddha System of Medicine for preparing Official Formularies/Pharmacopoeias with a view to prescribe working standard for preparation of drugs and to prescribe working standard for compound formulations including test for identifying purity and quality of the drugs. Central Council of Indian Medicine, constituted under IMCC Act, 1970, regulated the education of Siddha System

and Central Council for Research in Ayurveda and Siddha was established in 1978 with a view to initiate, undertake and regulate the research work in Siddha System of Medicine also.

RESULTS AND DISCUSSION

There are many plants, which have potential medicinal value. India is blessed with medicinal plant diversity as it is clear from the available literature. The earliest of the literature was studied dated 2838-B.C. from *Ebers papyrus*. A number of Indian treaties like Charak Samhita, Navanitakem, 'Indian medicinal plants' by Kirtikar and Basu and other literature were also used in this work.

Sometimes, ethnobotanical study of a single medicinal genus or species is undertaken by surveying various literature in relation to therapeutic uses and other uses, and examples of such work are Arora (1965), Bisset (1974), Shah and Kapoor (1974). They studied *Acorus calamus*.

Since every second green plant in India is medicinal plant, this number corresponds to more than 1/4th of the world known medicinal plant which are around 30,000 species. In the present work ethnomedicinal study was done by periodical and ethnomedicinal survey of rural knowledge of Jalaun District from the year 2004-2005.

A total of 5 plant species of ethnobotanical medicinally important have been included in present study.

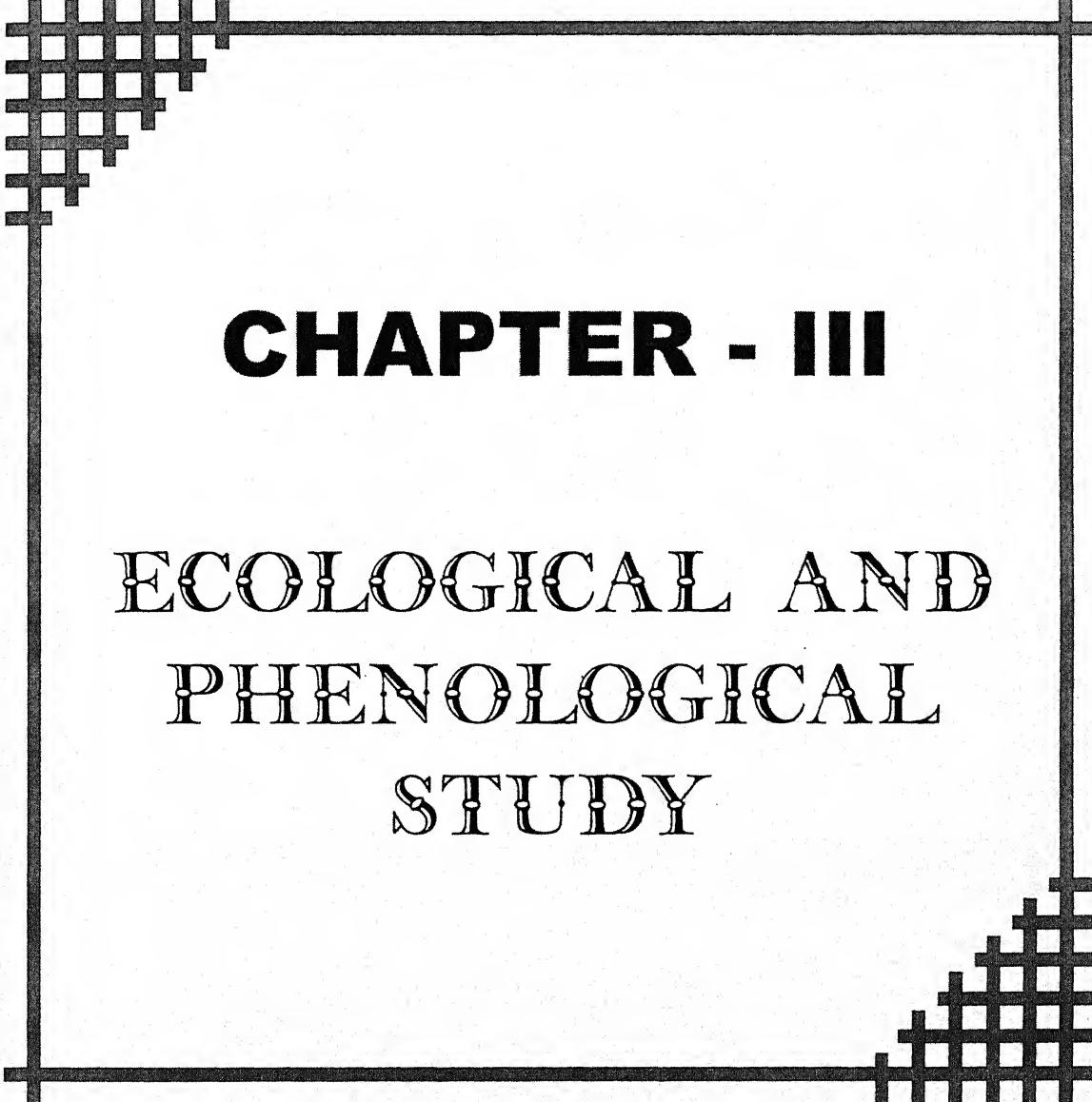
All plant species were collected, identified, processed and preserved in herbarium.

The plant species used by villagers are available in study area. It has been revealed that all 5 plants of ethnomedicinal importance belonging to different habits namely herb and shrub were included in present study. In the present study, families which are ethnomedicinally important are *Asteraceae*, *Caesalpiniaceae*, *Nyctaginaceae*, *Papaveraceae* and *Solanaceae*.

Some of the common diseases were described in present work, viz. Asthma, Bronchitis, Constipation, Cough and Cold, Cuts and Wounds, Diarrhoea, Dysentery, Eye diseases, Fever, Impotency, Bone fracture, Blood purification, Malarial fever and other such several ailments.

The present study has revealed some interesting plants which cure various types of human ailments. The native and local medicinemen of Jalaun district use locally available medicinal plant species. The studied plants are used to cure wide ranges of disease, the plants are *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens*.

After surveying the area it was observed that the aged persons in the rural area have some knowledge about herbal medicine. Certain plant species are used for number of diseases and their mode of application is variable. These plants are used singly or in combination with other species, they are sometimes used with other natural products, like honey, milk, metals and oxides of heavy metals in different system of medicine like Ayurveda, Unani, Siddha, Homeopathy and Home remedies.



CHAPTER - III

ECOLOGICAL AND PHENOLOGICAL STUDY

ECOLOGICAL AND PHENOLOGICAL STUDY

INTRODUCTION

Man's curiosity for the study of plants dates back to the earliest days of the human history. Because plants served his day to day necessities, he tried to study them in as much details as he could. During this endeavour he also tried to group the similar and dissimilar plants under separate categories for his own use. Our knowledge of the plants is now considered as remnant of our ancient heritage, because it could not be preserved intact. If one turns the pages of Indian history he comes across the different names of plants which have been coined on legendary, medicinal or ecological grounds. In those early days the plants of non economical values have not been described. Nearly the same story runs in the western countries, where herbalists like Albertus Magus, Jerome Block, John Ray and many others have done pioneer works in this direction.

Seasonal variations in the calorific values of tree foliage have been reported in a number of studies (Madgwick, 1970; Hughes, 1971; James and Smith, 1977). The calorific value of leaves decreased markedly during the growing season, but

increased again at the time of abscission or leaf fall (Hughes, 1971; James and Smith, 1977). The calorific value of *Pinus virginiana* branches showed an increase during the growing season (Madgwick, 1970). However, studies on the seasonal trends in calorific values of different individual parts of woody plants are limited.

The foremost prerequisite of ecological studies of any flora is the study of natural abode of plants or study of habitats. The characters of habitat are referred to as plant indicator, in general the vegetation is indicator of habitats. Balandin (1936) considered that only rarely individual species have indicator value. According to Braun-Balanquet (1932) characteristic species are collectively the best indicator of ecological conditions of community. Plants are admittedly a measure of the environment and the community indicates the nature of surroundings. Species which are less tolerant to many varying conditions are usually indicators since their growth requirements are exacting.

Depending upon the general appearance and growth, the species are grouped into different life forms. According to Oosting (1958) the classification of vegetation based on the general nature of plants viz. size, ever green or deciduous, herbaceous or woody and the position of perennating buds in the dormant season indicated 'Vegetation forms' (Clements, 1920) or 'Growth forms' (Warming, 1929) or 'Life forms' (Raunkiaer, 1934).

Argemone mexicana (Linn.)

Family - Papaveraceae

Description :

A robust herb, 1-2 ft. high; stem often almost woody below, simple or sparingly branched. Leaves 3-7 in. long, sessile, 1/2 amplexicaul, sinuate pinnatifid, glaucous, white spotted, prickly. Flowers 1.3 in. in diameter, sessile or subsessile, yellow or rarely white. Sepals horned at the top and bristle pointed. Capsule 3/4 - 1½ in. long, elliptic or oblong, bristly.

Distribution :

Throughout India, Introduced from America within the historic times. It flowers during the cold season. The juice and the oil yielded by the seeds are used medicinally; the oil is also valued for painting purposes.

Boerhaavia diffusa (Linn.)

Family - Nyctaginaceae

Description :

A diffusely branched herb; root stout, fusiform, root stock woody, stems 2-3 ft. long, slender, prostrate or ascending, swollen at the nodes, minutely hairy and sometimes viscid or subglabrous, often tinged with purple. Leaves rather thick, arranged

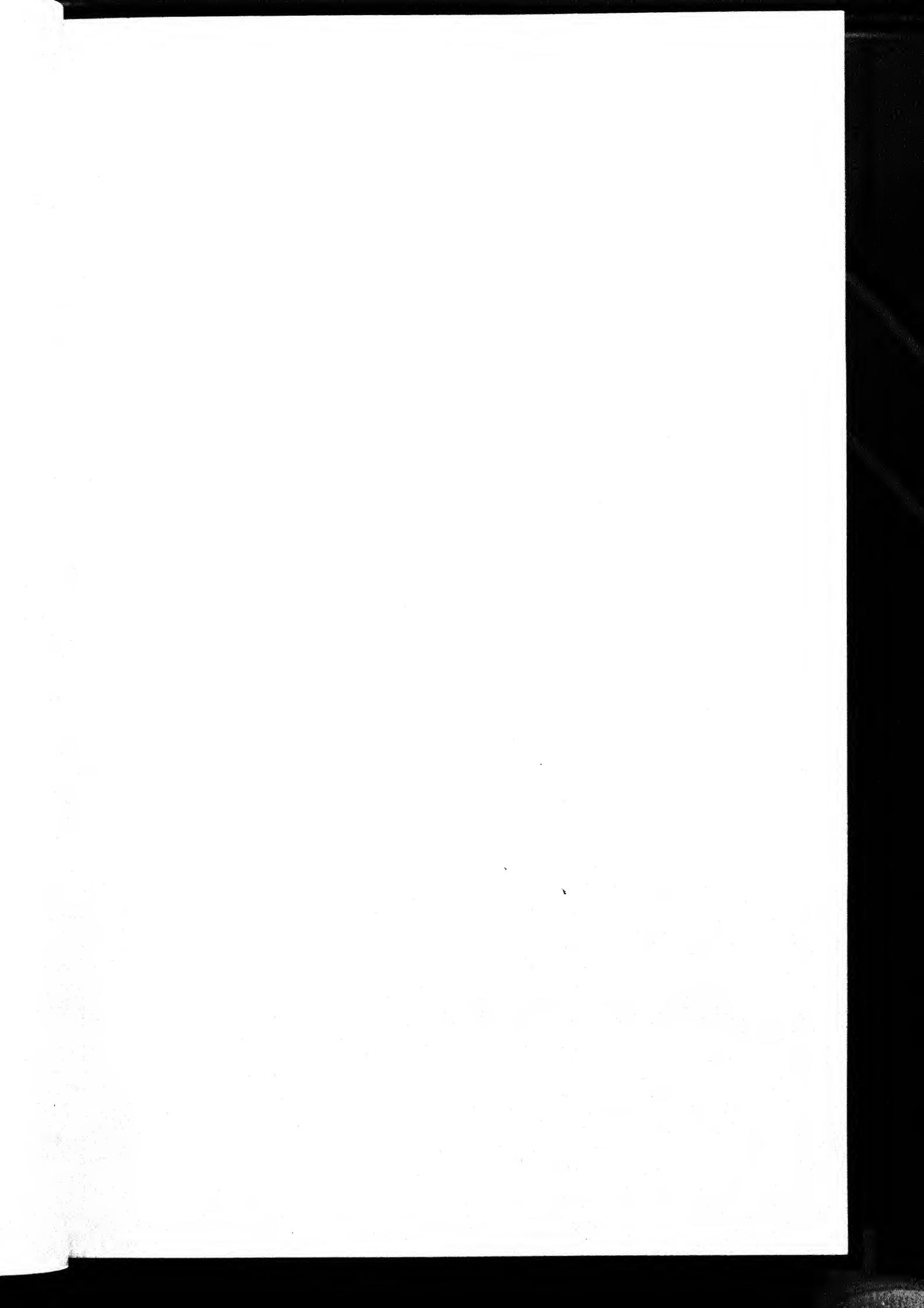


PLATE- I : Showing *Argemone mexicana*- Vegetative Stage

Vegetative Stage



PLATE - I



PLATE- II : Showing *Argemone mexicana*- Flowering stage

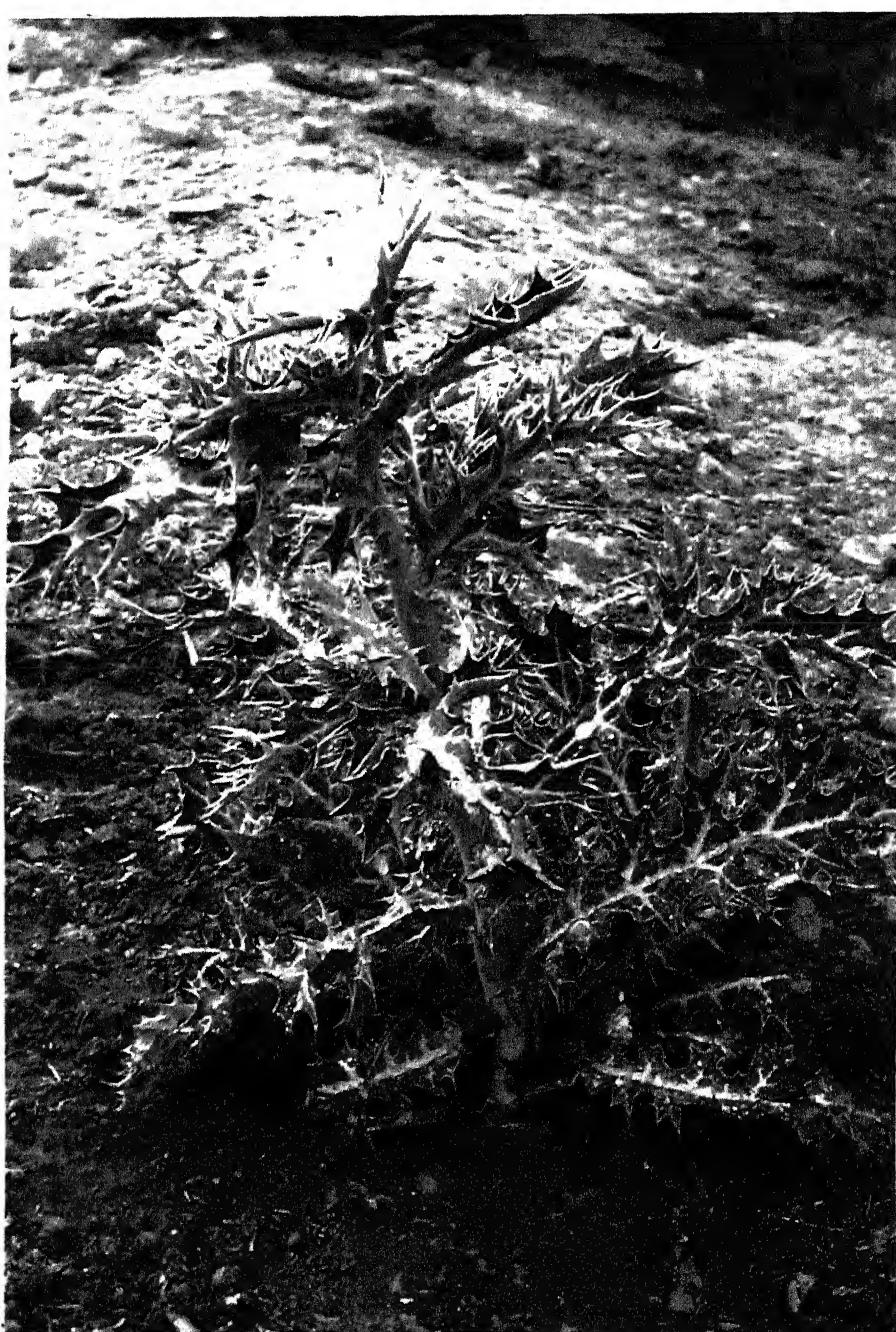


PLATE - II



PLATE- III : Showing *Boerhaavia diffusa*- Vegetative stage

stage



PLATE - III



PLATE- IV : Showing *Boerhaavia diffusa*- Flowering stage



PLATE - IV

in unequal pairs at each node, $\frac{1}{2}$ - $1\frac{1}{2}$ in. long, ovate oblong or suborbiculate, green and glabrous above, usually white beneath; base rounded or subcordate, margins subundulate, often pink; petioles about as long as the blade. Flowers minute, subcapitiate, 4-10 together in small bracteolate umbels forming slender long stalked axillary and terminal panicles, bracteoles, lanceolate, acute. Perianth $\frac{1}{8}$ in. long; tube glandular-hairy; limb red, funnel shaped, with five narrow vertical bands outside. Stamens 2 or 3, slightly exerted. Fruit $\frac{1}{8}$ in. long, clavate rounded, viscidly glandular on the 5 broad blunt ribs.

Distribution :

Throughout India, ascending to 7000 ft. in the warm valleys of the Himalaya; also in Ceylon and the Malay Peninsula; extending to China, Africa America and the Islands of the Pacific. The root is used medicinally and the leaves are eaten as a pot-herb. The viscid perianth-tube containing the fruit is easily detached and thus becomes widely distributed by animals.

Cassia obtusifolia (Linn.)

Family - Caesalpiniaceae

Description :

An annual or occasionally an undershrub upto 7 ft. high. Leaves 3-4 in long. petioled, not foetid, stipules $\frac{3}{4}$ in., linear,

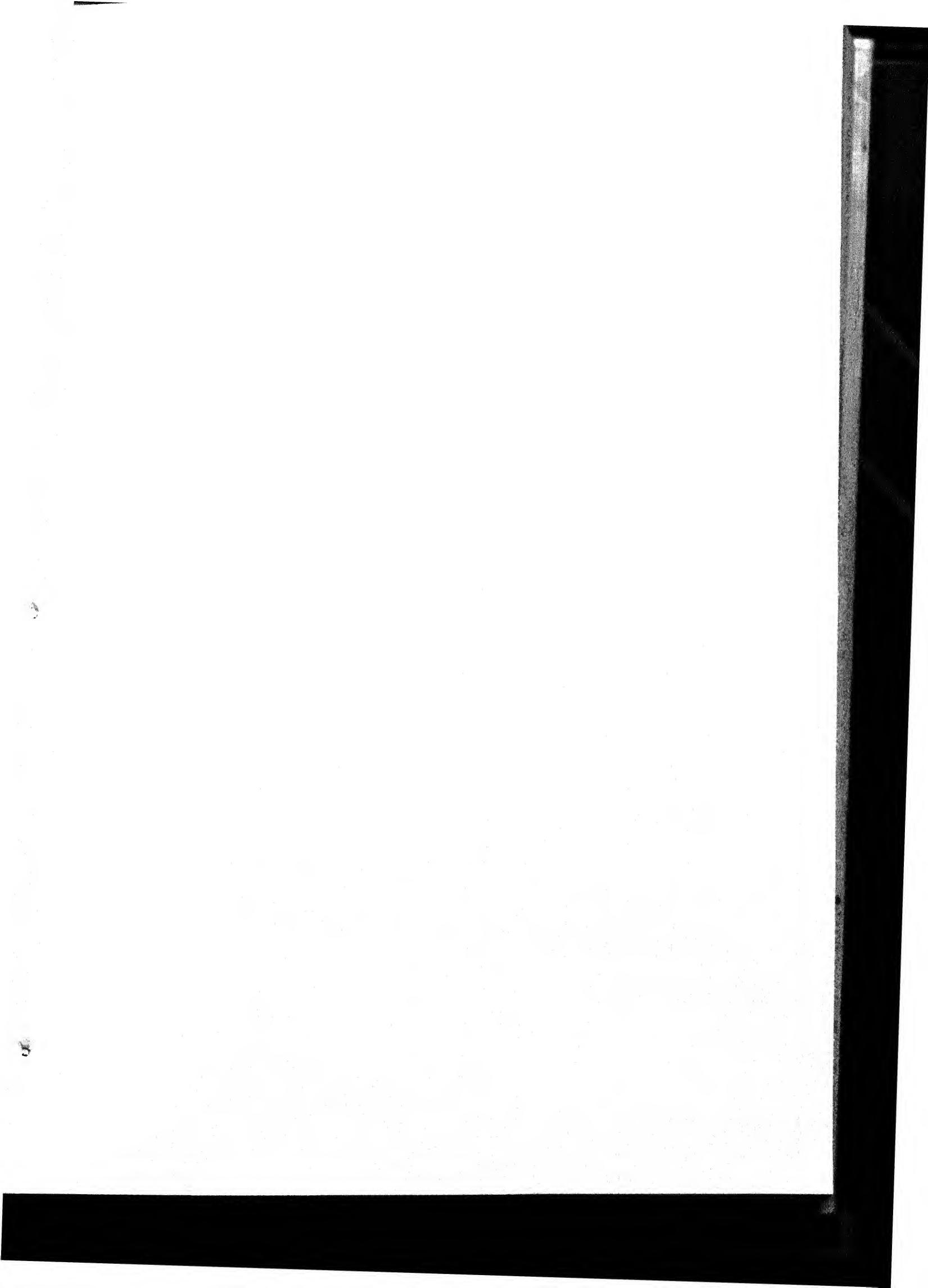


PLATE- V : Showing *Cassia obtusifolia*- Vegetative stage



PLATE - V

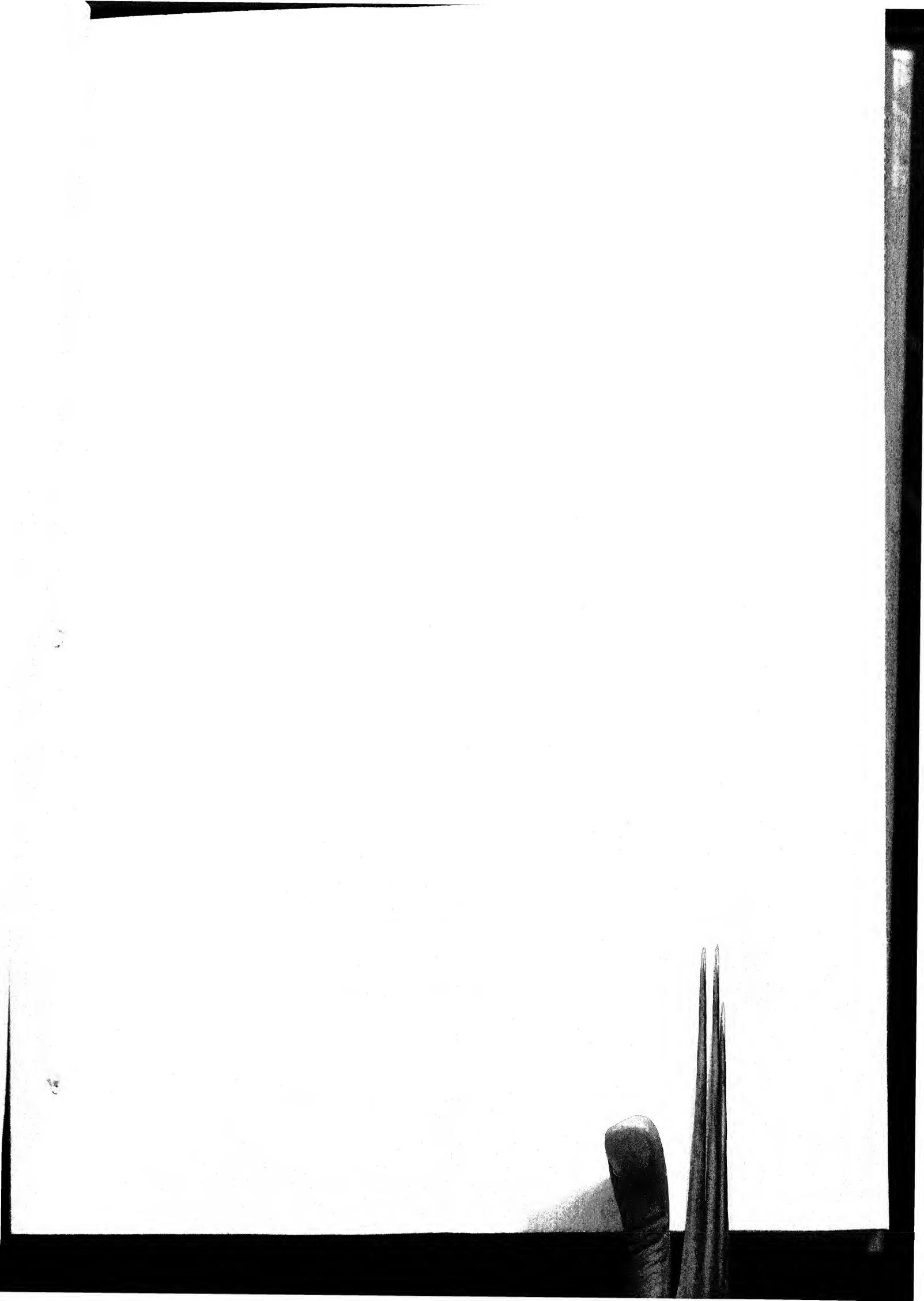


PLATE- VI : Showing *Cassia obtusifolia*- Flowering stage



Wearing stage



PLATE - VI

caducous; rachis puberulous deeply grooved above, furnished with a single conical gland between the lowest pair of leaflets, leaflet 3 pairs, 1-2 in. long, abovate-oblong, broadly dified at the apex, rather obliquely rounded at the base, membranous, green, glabrous or puberulous on both surfaces, lateral nerve 8-10 pairs, indistinct. Flowers usually in subsessile pairs in the leaf axils. Colyx 3-partite to the base, lobes green, petals bright yellow, 1/2 in. long. standard truncate, stamens 7, the 3 upper reduced to staminodes, pod 8-10 in. long, subterete, obliquely septate, valves membranous, glabrous, distinctly transversely reticulated sutures broad. Seeds 30-35, brown, shining.

Distribution :

Abundant in Northern, Western and Central India, ascending to 4000 ft. on the W.Himalaya; It is found also in Burma and is very common at Singapore. It was introduced originally from Tropical America.

Datura metel (Linn.)

Family - Solanaceae

Description :

Whole plant densely clothed with greyish tomentum, stem erect, 3-4 ft. high, stout, herbaceous, terete. Leaves 6-8 in. long. ovate lanceolate or broadly, entire or repand-dentate, densely tomentose on both surfaces and generally glandular, petioles 2½-3½

PLATE- VII : Showing *Datura metel*- Vegetative stage



PLATE - VII

PLATE- VIII : Showing *Datura metel*- Flowering stage



PLATE - VIII

in. long, inflated towards the middle, persistent and reflexed in fruit; teeth lanceolate, acuminate, unequal. Corolla about twice as long as the Calyx, white tinged with green below, pubescent outside, limb 10 toothed. Capsule globose, nodding, covered with long rather slender spines.

Distribution :

There is no record of this plant having been found within the limits of upper gangetic plain, though probably occurring near habitations in sub-Himalayan tracts. It is found not frequently in Kashmir and other parts of the North-West Himalaya. It is not uncommon in S.Europe, but it is supposed to have originally spread from S.America to all other parts of the world. It is regarded in India as being the most poisonous of all the species of *Datura* and for this reason it is much resorted to for criminal purposes.

Tridax procumbens (Linn.)

Family - Asteraceae

Description :

A weak straggling pubescent or hispid herb, 1-2 ft. high. Leaves few, petioled, 1-2 in. long, ovate or lanceolate, coarsely dentate or pinnatisect, clothed on both sides with bulbous based hairs, base acute, penduncles often more than one foot long,



PLATE- IX : Showing *Tridax procumbens*- Vegetative stage





PLATE - IX

PLATE-X : Showing *Tridax procumbens*- Flowering stage





PLATE - X

solitary, slender, sparsely pilose. Heads 3/4 in. in diameter. Outer invol-bracts densely hairy, ovate acuminate; inner longer, membranous, slightly pubescent on the back. Ligules of ray flowers yellow; 3-partite. Achenes 1½ in. long, brown, pappus of many shining feathery bristles.

Distribution :

A common plant throughout India. Indigenous in Central America. Abundant within the area by roadsides, in grassy places and on old walls. Flowers during the greater part of the year.

PHENOLOGY

Phenology is defined as the study of the timing of recurring biological phases, the causes of their timing with regards to biotic and abiotic forces and the interaction the interrelation among phases of the same or different species. The "Phase", or "Phenophase", may be the date of first flowering, budbreak, unfolding of first leaf, first bird migration, etc. The timing of phenophases is very important in biological systems and processes as it influences factors like the length of the growing season, frost damage, timing and duration of pests and diseases, water fluxes, nutrient budgets, carbon sequestration and food availability.

Phenology as a scientific discipline, although evinced academic interest failed to attract field investigations, totally on

Indian trees, wild and cultivated, over years. Review of literature reveals that the first disciplined approach has been made in India with the dawn of the 20th century. It is in 1906, Blatter correlated the flowering season with the climate and Harper while describing the Phytogeography of Georgia, USA provided a Phenogram to consolidate all the phenological features. Sagreiya (1942) has highlighted the technique for collecting of Phenological record of shrubs and ornamental trees.

Scientific research has indicated that the timing of Phenophases is clearly correlated with air temperature, soil moisture, solar illumination and snow cover but vary from species to species. Consequently, climate change will cause species-specific phenological changes resulting in modification of species reproduction, competition between species and changes in species-species interaction. Ecosystem models assess that in the next 50 years growing season length in Europe will change upto -3 to +3 months (respectively southern and middle part of Europe). Therefore, phenological changes in response to climatic change will have a wide range of consequences for ecology, agriculture/forestry and human health. In addition to its importance for these issues, phenological data are very valuable for remote sensing studies and education purposes.

Since the timing of phenophases is strongly correlated with climate variables (notably temperature and precipitation). Often easy to observe and a wide range of applications, almost all European countries have had their own phenological monitoring networks. These networks have resulted in many long-term valuable datasets of which several go back to the 19th century or even before and which are unique in the world. Currently, thousands of people all over Europe (both professionals and volunteers) are still continuing their observations following strict guidelines. Only a very small part of the data is used to feed a wide variety of phenological models, which are often part of ecological, agricultural and economic models.

It is increasingly being recognised that phenological records provide an integrative indication of the sensitivity of natural systems for climate change and that they have a clear value to climate impact assessment. Long term phenological monitoring over a wide range of latitudes and altitudes is, therefore, an essential component of earth observation programs and global change monitoring. It can function as an important "early warning mechanism". Therefore, phenology is presently developing rapidly as a worldwide discipline.

Currently, more and more scientific research shows that changes in timing of phenophases already have to take place on a

large scale in agreement with the observed warning in the last decades.

It is essential that the data are collected around the year, possibly for two consequent years, before consolidation and evaluation. More often the data are discussed with field studies at any convenient time for a month or part of an year and not continuously atleast for an year.

However the available literature help correlating the growth variations under different climatic conditions prevailing in different parts of the country. The construction of phenological charts for the vegetation of Central Himalayas (Bisht *et al.*, 1986), Kashmir (Irshad *et al.*, 1986), Arunachal Pradesh (Beniwal, 1987; Beniwal & Singh 1989), Srinagar (Kaul and Raina, 1980), Maharashtra (Buit, 1966, Ghate and Kumbhojkar, 1991), Garhwal Himalaya (Ansari, 1989; Ansari and Bhadola, 1989), and for the group of Andaman Islands (Ganapathy, 1965; Ganapathy and Rangarajan, 1964; Sharma and Rajaswaran, 1970) Dehra Dun (Krishnaswamy and Mathuda, 1954) and Tamil Nadu (Arjunan and Ponnammal, 1993) have been attempted from time to time.

The phenological events reported from year to year even within a geographic region may vary due to variations in weather and local environmental factors. Shelford (1929) considered

phenology to be a seasonal event. Daubenmire (1947) defined phenology to include all studies as the relationship between climatic factors and periodic phenomenon in plants. According to ecological society of America, the term phenology deals with the appearance of certain characteristic events during the life cycle of plant. The studies on phenology of tropical rain forest have been done by various investigators i.e., Scheffler (1901), Schimper (1903), Wright (1905); Troup (1921), Holttum (1931), Davis and Richards (1933), in Britain. The phenological investigations in temperate forest trees were done by Holttum (1931), Leven (1951), Gill (1955) and Ahlgren (1957). The phenological behaviour of forest trees in India have been studied by a few workers i.e. Krishnaswamy and Mithanda (1954), Gupta (1960), Bhatnagar (1968), Joseph (1978), Kaul and Raina (1980), Pandey and Sharma (1986), Beniwal (1987), Tripathi (1987), Beniwal and Singh (1990) and Dubey (1991).

In the past, a large number of workers have studied the factors influencing the phenological behaviour of plants. But this work is based on agriculture and other cultivated plants. There is a wide fluctuation in the phenological responses of forestry tree species from year to year on account of climatic changes. These responses also vary from one region to another (Ahlgren, 1957). Apparently, such wide variation in phenology is an indication of its

regulation by a combination of various factors. Krishnaswamy and Mathuda (1954) have divided the factors in the internal and external ones. Internal factors are directives in development of species in determining the pattern of its phenological behaviour. External factors have been observed as humidity (Holttum, 1931), precipitation (Champion, 1934), temperature (Leven, 1951 and Ahlgren, 1957), soil, moisture, light intensity and its duration (Warieng, 1951 and Njoker, 1963), weather (Lindsey ad Newan, 1956) and micro climate (Jackson, 1966).

Literature on the phenology and annual growth pattern of teak is scanty. Champion (1934) studied the seasonal progress of height growth of teak saplings at Dehra Dun. Troup (1921) as well as Krishnaswamy and Mathuda (1954) reported on the phenology. As most of these studies were made at Dehra Dun, outside the normal range of distribution of teak, these data cannot be taken as typical. Our general observations had indicated about a month's difference in flushing time even between southern and northern Kerala, which was apparently related to differences in the temporal distribution of rainfall. Phenological variation due to provenance difference has also been reported (Kaushik, 1956).

According to Sharma *et al.* (1965), floral biology of *Pogostemon patchouli* syn. *Pogostemon cablin* flowers under the climate of Itanagar, Arunachal Pradesh was studied. Flowering was

profuse during second and third week of March. Maximum anthesis was recorded between 10 to 11 am. and another dehiscens 6 hours after anthesis. Pollens were found to be sterile.

Morphology of glorious lili (*Gloriosa superba*) flower, flowering season and duration, flower bud development, time of anthesis, temperature and relative humidity in relation to anthesis, time of another dehiscene, stigmatic receptivity and mode of pollination are discussed by Swarmapriya, *et al.* (1995).

Steluta (1997) studied floral biology and hybridization technique of *Salvia sclarea* (L.).

Phenology is an important natural phenomenon recurring periodically with respect to the change of season and physical environment.

MATERIALS AND METHODS

The data were collected at regular interval of 15 days for the whole year from March 2004 to March 2005 and a phenogram was prepared following the methods of Harper (1906).

The Phenological characteristics such as vegetative growth, flowering fruiting, fruit ripening in five species viz. *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel*, *Tridax procumbens*.

RESULTS AND DISCUSSION

The phenological changes of plants in relation to various phases of their life cycle and seasons are governed by a number of composite factors. In the past few decades a number of workers have studied the factors which have a direct influence on the phenological behaviour of plants. Most of these studies were conducted on agricultural and other cultivated plants. Due to changes in the climatic condition, there is wide fluctuation in the phenology of a species from region to region. Krishnaswamy and Mathuda (1954) have divided the factors influencing phenology into two viz. internal and external ones. Internal factors control the development of the species and in determining the pattern of its phenological behaviour, while external factors modify the influence of internal factors and account for fluctuation. External factors include humidity (Holtum, 1931), precipitation (Champion, 1932), temperature (Leven, 1951 and Ahlgren, 1957), soil moisture, light intensity and its duration (Wareing, 1951 and Njoku, 1963), weather (Lindsey and Newan, 1956) and conditions of microclimate (Jackson, 1966).

Observations on five medicinal plant species viz. *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel*, *Tridax procumbens* were made during the course of these studies. The data on different phenological events of five

medicinal plant species recorded for year 2004 to 2005 are depicted in fig. 5 and 6.

The morphological features of the selected medicinal plants are presented in table 3.1.

Of the five medicinal plants observed 2 species *A. mexicana* and *D. metel* have vegetative growth during the month October to December, whereas *C. obtusifolia* shows such activities between June to August. *B. diffusa* and *T. procumbens* show the vegetative growth almost throughout the year.

Most of the plants enter into the reproductive phase after rainy season. *C. obtusifolia* shows flowering during August to September, whereas *A. mexicana* and *D. metel* December to March. The flowering phase of *B. diffusa* and *T. procumbens* is during September to February.

The fruit ripening of *A. mexicana* is April to May, in *C. obtusifolia* is October to November and in *B. diffusa* and *T. procumbens* fruiting time in November to December. In *D. metel* fruit ripening is February to March.

Similar results as present observation were described by (Puttanaik 1997) who recorded the floral biology of Prime rose. Ronse Decraene (1998) studied floral development and anatomy of *Moringa oleifera*. Diallo (1997) recorded the floral biology and

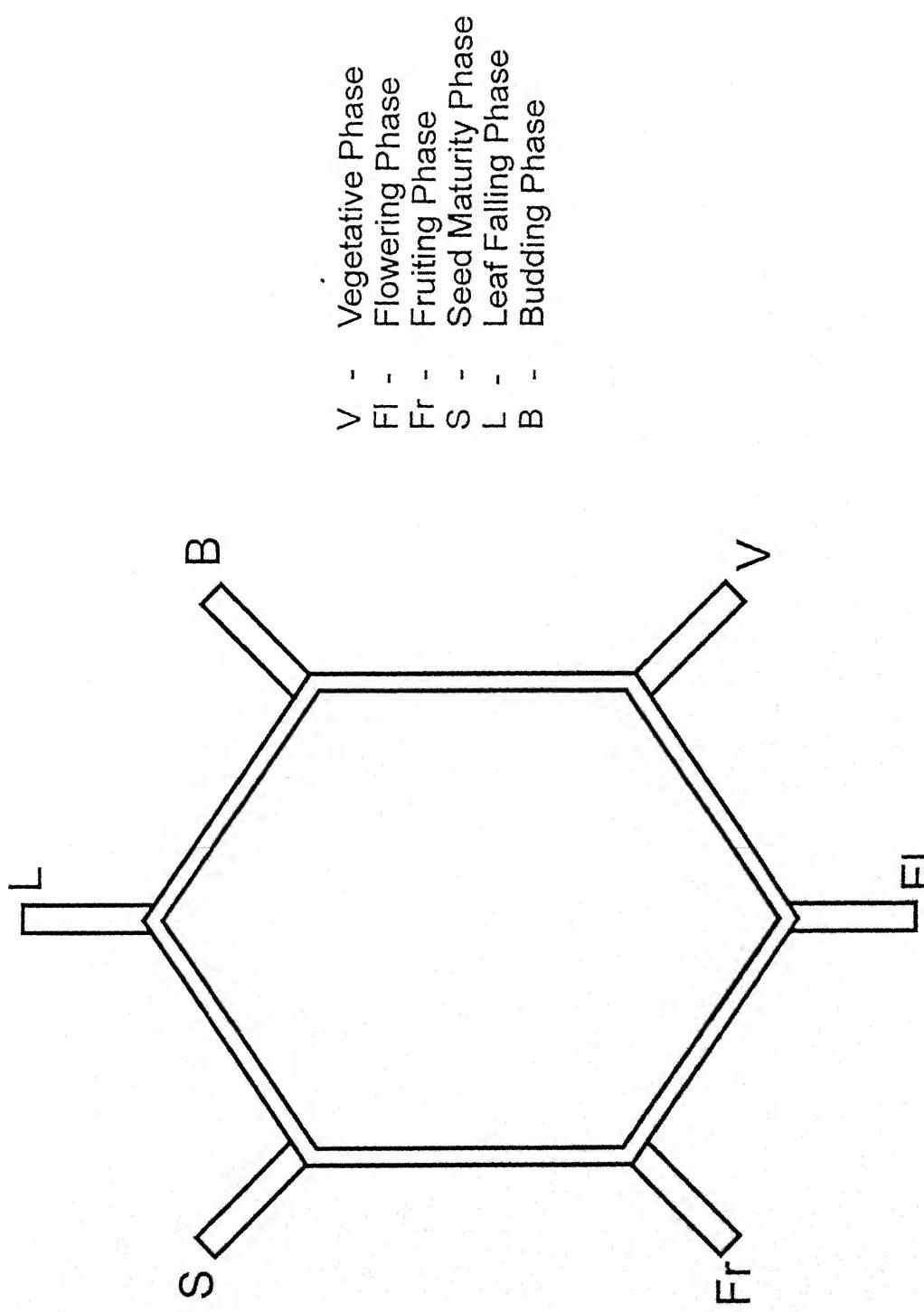


Fig. 5 : Symbol phenological phase

Sl. No.	Name of Species	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1	<i>Argemone mexicana</i>												
2	<i>Boerhaavia diffusa</i>												
3	<i>Cassia obtusifolia</i>												
4	<i>Datura metel</i>												
5	<i>Tridax procumbens</i>												

(I = Start of Phenophase)

Fig. 6 : Phenograms of selected medicinal plants

Table 3.1 : Morphological features of the selected medicinal plants

S.No.	Name of Species	Family	Type of Fruit	Seed colour after maturity	Seeds/g
1.	<i>Argemone mexicana</i>	Papaveraceae	Capsule	Black	463
2.	<i>Boerhaavia diffusa</i>	Nyctaginaceae	Clavate, rounded	Brownish black	553
3.	<i>Cassia obtusifolia</i>	Caesalpiniaceae	Pods	Pale	63
4.	<i>Datura metel</i>	Solanaceae	Capsule	Yellowish brown	82
5.	<i>Tridax procumbens</i>	Asteraceae	Achenes	Brown	2563

pollination in *Acacia senegal* (L.) Wild.

Baruah & Saha, (1999) studied flowering in *Bacopa monnieri* and it was observed throughout the year with a flowering peak during February. Maximum anthesis took place between 8.30 am. to 9.30 am. Anther dehiscence was maximum after 3 hours of anthesis. Pollen grains were round, a few spherical to oblong in shape with 60 per cent fertility.

CHAPTER - IV

SEED COLLECTION AND SEED CHARACTERISTICS

SEED COLLECTION AND SEED CHARACTERISTICS

INTRODUCTION

Seed Collection :

The knowledge of ripening period of seeds, time of maturity of seeds, ability to recognise mature ripe seeds and dispersal characteristics is essential during field collection of abundant quality of health and vigorous seeds of different sites of plant species. Fruit maturation depends on the varying environmental conditions under which the fruits and seeds are developed. The planting value of seed and its storability is directly related to the level of maturation of seeds at the time of collection, extraction and processing of seeds in large quantities in the field. It will be economical and practicable if exact stage and time of collection of seeds of different species are known. Method of seed collection and extraction of seeds from the fruit also depends upon the nature of the species. Proper care during collection and processing of seeds is necessary for maintaining the healthy lot free from injurious agencies.

Seeds were collected at different time of maturation stages as follows :

- (a) First time : Seed collection was done when fruits were fully formed and ripe but dehiscence did not take place. They were collected by hand plucking.
- (b) Second time : When the fruits were just ready for dehiscence and when fruit fell down by slight hand jerk.

Method of seed collection and extraction of seed from the fruit depends upon the nature of the species. During collection and processing of seed proper care is necessary for aminating the healthy lot, free from injurious agencies. The majority of the species have a seedling season, which is very short say few weeks only. It is during this short period the maximum amount of seed is to be collected without allowing the dehiscence process or when they fall down on the ground. Seed should always be collected from selected plant species only.

The main objects of seed collection are :

- (1) To meet continuous short and long term supply of reproductive material for plantation programmers.
- (2) To ensure the supply of reproductive material for scientific trials and introduction of species in exotic area.
- (3) For the establishment of genetic bank, expansion of arboreta, botanical gardens and seed herbaria, good supply of seed is needed.

- (4) It is desirable to collect seeds during good seed years because during poor seed year quality of seed is very poor. Good seed year also furnish a seed sample which fully represents the population genetically.
- (5) Seed is a basic tool for secured food supply and the seed principle means to secure crop yield in less, favourable production area, (Feistrizer, 1975).

In present investigation different localities of seed collection of selected medicinal plant species are presented in table 4.1.

Seed Size and Weight :

The germination and subsequent growth was influenced by the seed size. Seed size has been known to be affected by the environment during seed development, obviously small seeds are produced under unfavourable conditions. The seed germination, vigour, processing recovery and field stands are thus reported to be regulated by the seed size (Dighe and Patil, 1986).

Kandya (1978) reported that large seeds are usually heavier because the size of the seeds in fact is a function of endosperm quantity contained inside the seeds. Therefore, the fast germination of the seeds, fast growth of seedlings in the initial phase may be a reflection of the amount of endosperm or endosperm

Table 4.1 : Locality of seed collection of selected medicinal plants

S.No.	Name of Species	Local Name	Family	Locality	Month of Seed Collection
1.	<i>A. mexicana</i>	Satyanashi/ Pili Katari	Papaveraceae	Orai, Jalaun Konch, Kalpi	April
2.	<i>B. diffusa</i>	Punarnawa/ Pachakeera	Nyctaginanaceae	Orai	November to December
3.	<i>C. obtusifolia</i>	Pumar/ Chakunda	Caesalpiniaceae	Orai, Konch	October to November
4.	<i>D. metel</i>	Kala Dhatura/ Shiv-phul	Solanaceae	Orai, Kalpi	February to March
5.	<i>T. procumbens</i>	Ghamra/ Phooli	Asteraceae	Orai, Jalaun Konch, Kalpi	November to December

nutrient pool. Gupta *et al.* (1983), also reported that the size usually reflect the comparative nutrient pool and energy of seed which affect the further growth and development of seedlings.

Positive correlations between size and vigour of the plant which support the fact that large or heavier seeds give rise to more vigorous plants and better yield, particularly when equal number of seeds per unit area are planted (Baldwin, 1942; Fowellis, 1953). Generally larger seeds were found to germinate faster and more completely than the smaller ones and to produce the seedlings where initial growth was greater.

Seed Morphology :

A large variety of seeds, are found among the plant species, seed size, seed colour, seed structure, seed coat texture and several appendages present on the seed like aril, caruncle, funiculus etc, are the several parameters on which the range of variation is marked. These variations are observed in inter-specific species and intera-specific species of plants too. Interspecific variations are more marked than intra-specific, as the interspecific differences characteristically reflect the differences in seed behaviour among various plant species.

It has also been reported that the unfavourable environmental variations also affect the seed size and weight, which

normally produces smaller and lighter seeds, affecting the seed germination, seed vigour, field stand and processing recovery.

A natural indication is received from seed size and weight, as it plays a vital role in seed germination behaviour, because larger and heavier seeds are supposed to possess more nutrient contents. In some cases, weight of seed coat may also be more, but vitality and vigour depends mainly on more nutrient content and a perfect balance in biochemical constituents within the seeds. There is no apparent difference between a dead and living seed, but they are differentiated only on the basis of mutual interactions between the metabolites of seeds, which are responsible for seed vitality and viability.

The stresses of habitat and forces operative for the perpetuation of the species, affect, the seed morphology to a great extent.

Morphological characters of many seed varieties in various plant species has been studied by numerous scientists (Chaurey, 1953; Rathore, 1968; Athya, 1980 and Jain 1962).

Quality seed is the significant input in all crop production programmes. The value of pure seed can hardly be over emphasised. The viability and germination are important factors which control the vigour of seedling in the nursery. Progressive

decrease in germination of stored seeds have been observed in studies conducted elsewhere (Khan, 1977). The height, girth, number of leaves and branches are the most important morphological characters which contributes to seedling vigour of seedling in the nursery depends on overall growth behaviour of these characters. The purpose of present study is to estimate the germination behaviour of seeds of five different plant species. The study also aims to investigate the various growth pattern of seedling in the nursery and to work out the correlation trend between the shoot and root growth parameters (Khan, 1977).

The environmental conditions, under which plant is growing, especially during stress, seed morphology is a main character assessing the extent of dispersal of seeds (Mayer *et al.*, 1963; Singh, 1968). The effect of seed grading by size on germination and growth of pine seedling was reported by Ghose *et al.*, (1976). Result of various experiments have shown that average dimensions of the medium sized seeds give high mean in daily germination as compared to larger and smaller sized seeds, which is quite low in percentage. In comparison to smaller and big seeds, medium sized gave higher mean of daily germination, total biomass, high root shoot ratio of seedlings. The effect of seed size in *Shorea robusta* plant was reported by Champion (1932). Vanangamudi and Palaniswamy (1988) quoted that plant height is directly proportional

to seed size. Separation by seed size has enhanced production of plantable seedlings in some plant species at certain times. The effect of seed size for different tree species have been studied by various scientists. Some species like *Pinus rouxburghii* (Chauhan and Raina, 1980), *Quercus alba*, *Q. robur* and *Q. velutina* (Korstain, 1927) and *Pinus oocarpa* (Kandya, 1978) have shown significant co-relation between germination rate and seedling size.

Sivasubramanian (1997) observed that irrespective of colour categories, *Moringa oleifera* seeds were stored better in polythene bags than in cloth bags. Black coloured seeds were superior by registering higher values for seed vigour and followed by brown coloured seeds; whereas white coloured seeds recorded very poor germination.

Chauhan (1988) studied the metrological analysis of 20 seed sources of *Bauhinia variegata* were carried out to study morphological variations under nursery conditions. The seed sources formed 6 distinct groups on the basis of shoot dry weight per seedling and height of seedling. Within group morphological variations were significant except for group II and III. Majority of high scoring sources were in group V and VI characterized by high seedling dry weight. For immediate gain seed sources of Solan and Palampur may be used for operational plantation programme NSL, New Delhi.

Many other workers like Chauhan (1980), Dunlop (1984), Gupta (1983), Hume (1946) and Srimati (1997) have done the work on seed collection, storage, seed size and weight, parameters.

MATERIALS AND METHODS

Seed collection from fruit was done during the year 2004 to 2005. Seed collection of the species *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens* was done from different sites viz. Orai, Jalaun, Konch and Kalpi.

The seeds were collected by following methods :

- (1) The seeds were collected by hand jerk or on their own possibly by the formation of abscission layer.
- (2) Seeds were collected directly from the plant by hand plucking.

RESULT AND DISCUSSION

During seed collection it is essential to have clear knowledge of ripening period of seed, time of maturity and ability to recognise mature and ripe seeds for collection of good quality of seeds of different species *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. It is observed that the seeds collected by slight hand jerk before dehiscence give higher percentage of

germination during preliminary studies and hence only these seeds were used for all further experiments. It is observed that the seed collection of five species should be done when the fruits are in advanced stage of dehiscence to avoid the loss in number of seeds viability and fungal attack.

Environmental stress has a great bearing on the seed morphology. Generally it is observed that bigger seed size and more weight of seed result in large amount of reserve food available to the embryo. Data on seed dimensions of different species are presented in table 4.2, 4.3, 4.4, 4.5 & 4.6.

Among the size grades the results of the experiment revealed that germination and seedling vigour decreased with decline in the size of seeds.

Argemone mexicana :

In the species *A.mexicana* fruits are capsule, prickly, oblong ovoid. There are many seeds (356-470) in the fruit. Seeds are black in colour, globose and netted (Plate 11). Per gram seed weight contains 463 seeds. Average seed length is 1.94 mm and width 1.90 mm.

Boerhaavia diffusa :

The fruit is achene in *B. diffusa*. The fruit contains only

Table 4.2 : Seed dimension of medicinal plant *Argemone mexicana*

S.No.	Seed length (mm)	Mean Value	Seed width (mm)	Mean Value	No. of Seeds/ gram
1.	1.9		1.8		
2.	1.8		1.8		
3.	2.0	1.94	1.9	1.88	463
4.	2.0		1.9		
5.	2.0		2.0		

Table 4.3 : Seed dimension of medicinal plant *Boerhaavia diffusa*

S.No.	Seed length (mm)	Mean Value	Seed width (mm)	Mean Value	No. of Seeds/gram
1.	2.3		1.0		
2.	2.3		1.0		
3.	2.5	2.5	0.9	0.94	553
4.	2.8		0.9		
5.	2.6		0.9		

Table 4.4 : Seed dimension of medicinal plant *Cassia obtusifolia*

S.No.	Seed length (mm)	Mean Value	Seed width (mm)	Mean Value	No. of Seeds/ gram
1.	5.0		2.5		
2.	5.0		2.7		
3.	4.5	4.7	2.8	2.4	63
4.	4.0		2.0		
5.	5.0		2.0		

Table 4.5 : Seed dimension of medicinal plant *Datura metel*

S.No.	Seed length (mm)	Mean Value	Seed width (mm)	Mean Value	No. of Seeds/ gram
1.	4.0		3.2		
2.	4.2		3.8		
3.	4.1	3.9	3.2	3.1	82
4.	3.5		3.1		
5.	3.7		2.2		

Table 4.6 : Seed dimension of medicinal plant *Tridax procumbens*

S.No.	Seed length (mm)	Mean Value	Seed width (mm)	Mean Value	No. of Seeds/ gram
1.	2.4		0.9		
2.	2.3		0.8		
3.	2.3	2.4	0.8	0.9	2563
4.	2.5		1.0		
5.	2.5		1.0		

PLATE- XI : Showing *Argemone mexicana*- Seeds

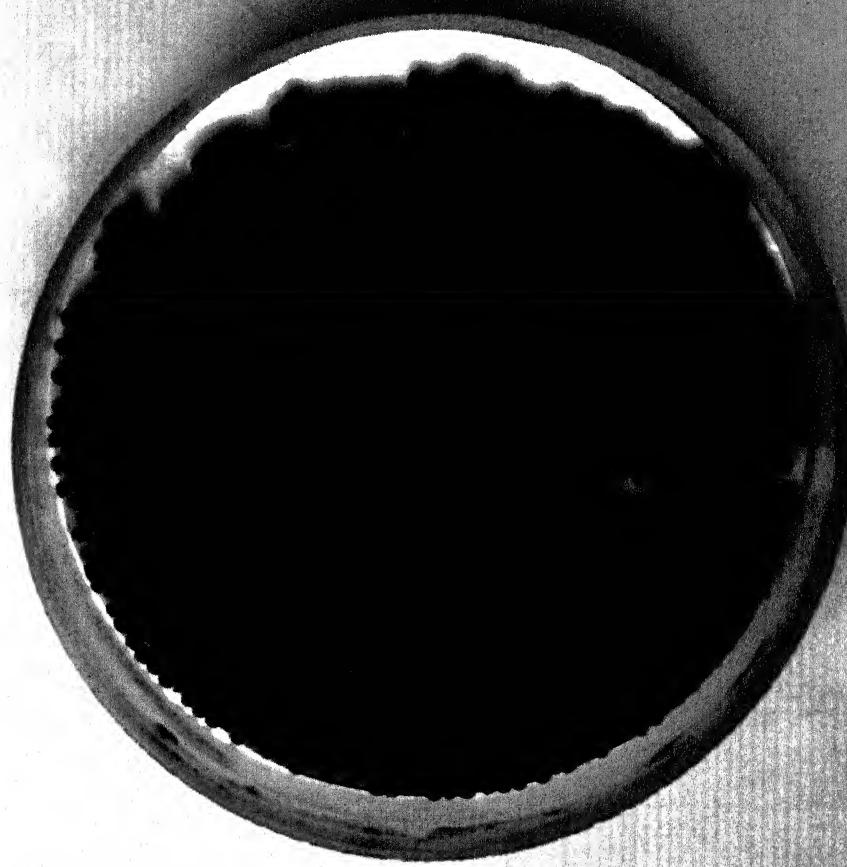


PLATE - XI

one seed. The seeds are ovate and brownish black in colour (Plate 12). Per gram seed weight contains 553 seeds. Average seed length is 2.5 mm and width 0.94mm.

Cassia obtusifolia :

In *C. obtusifolia* mature fruit (pod) is 12.5-20 cm long, subtetragonal, obliquely septate and purberulous containing many seeds (25-30). Colour of the seed is pale (Plate 13). Per gram seed weight contains 63 seeds. Average seed length was 4.7 mm and width 2.4 mm.

Datura metel :

The fruit of *D. metel* is observed to be capsule. The capsule is globose, covered all over with numerous flesh prickles. Each capsule contains many seeds (128-197). The seed is smooth and yellowish brown in colour (Plate 14). Per gram seed weight contains 82 seeds. Average seed length is 3.9 mm and width 3.1 mm.

Tridax procumbens :

The fruit of *T. procumbens* is achene bearing only one seed. Seeds are oval, minute and brown in colour with pappus of many shining feathery bristles (Plate 15). Per gram seed weight contains 2563 seeds. Average seed length is 2.4 mm and width 0.9 mm.

PLATE- XII : Showing *Boerhaavia diffusa*- Seeds

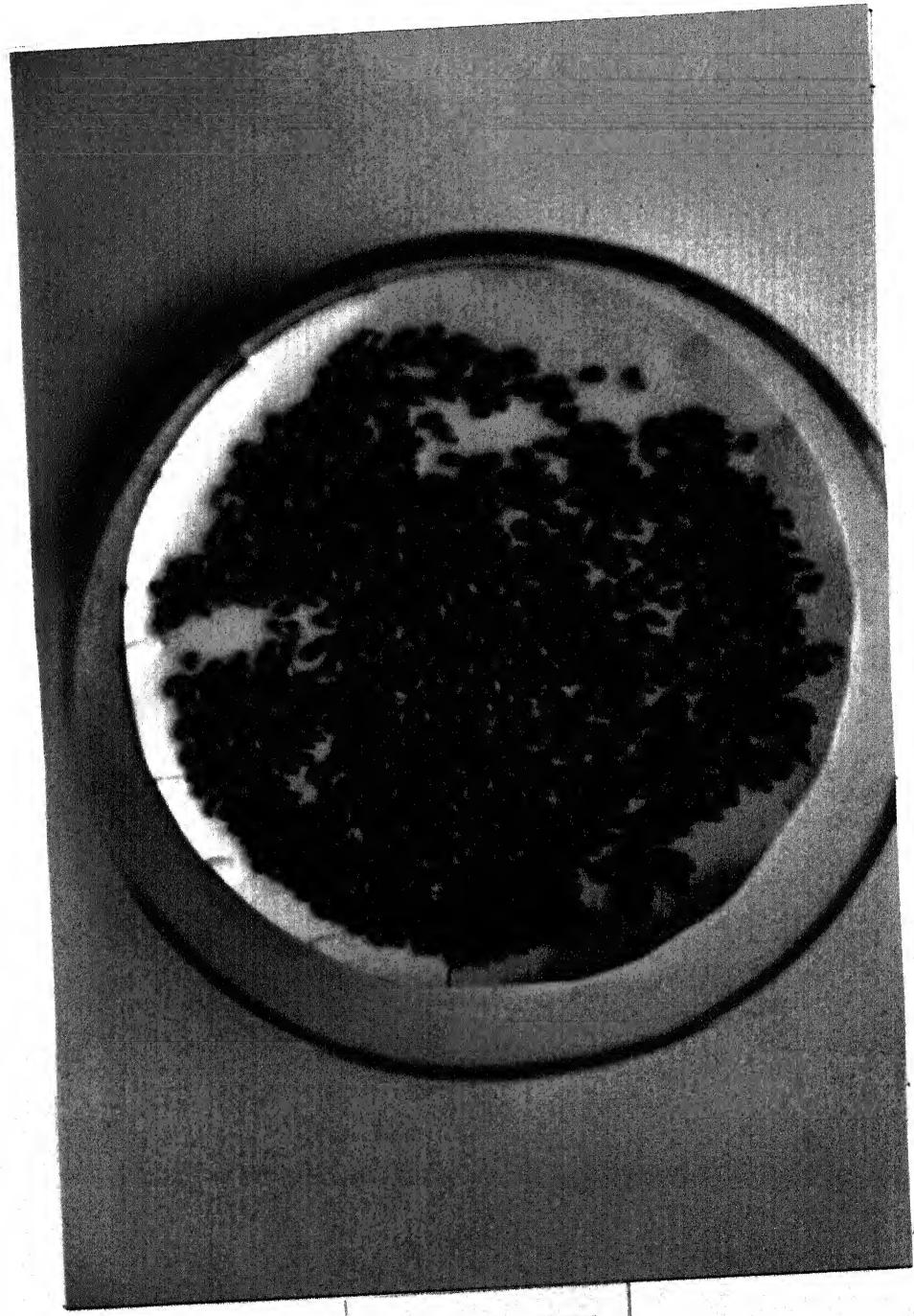


PLATE - XII

PLATE- XIII : Showing *Cassia obtusifolia* - Seeds



PLATE - XIII

PLATE- XIV : Showing *Datura metel* - Seeds

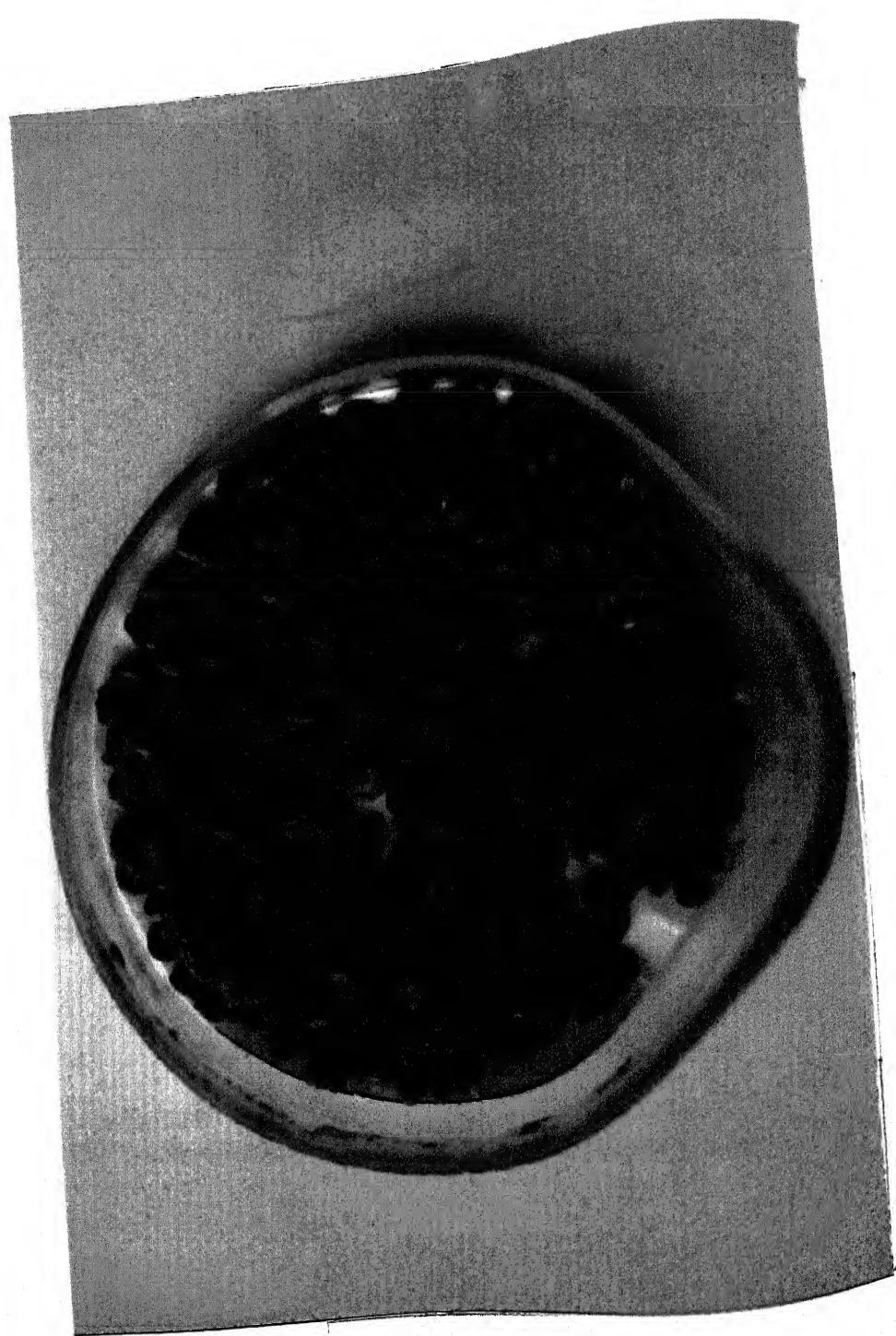


PLATE - XIV

PLATE- XV : Showing *Tridax procumbens* - Seeds

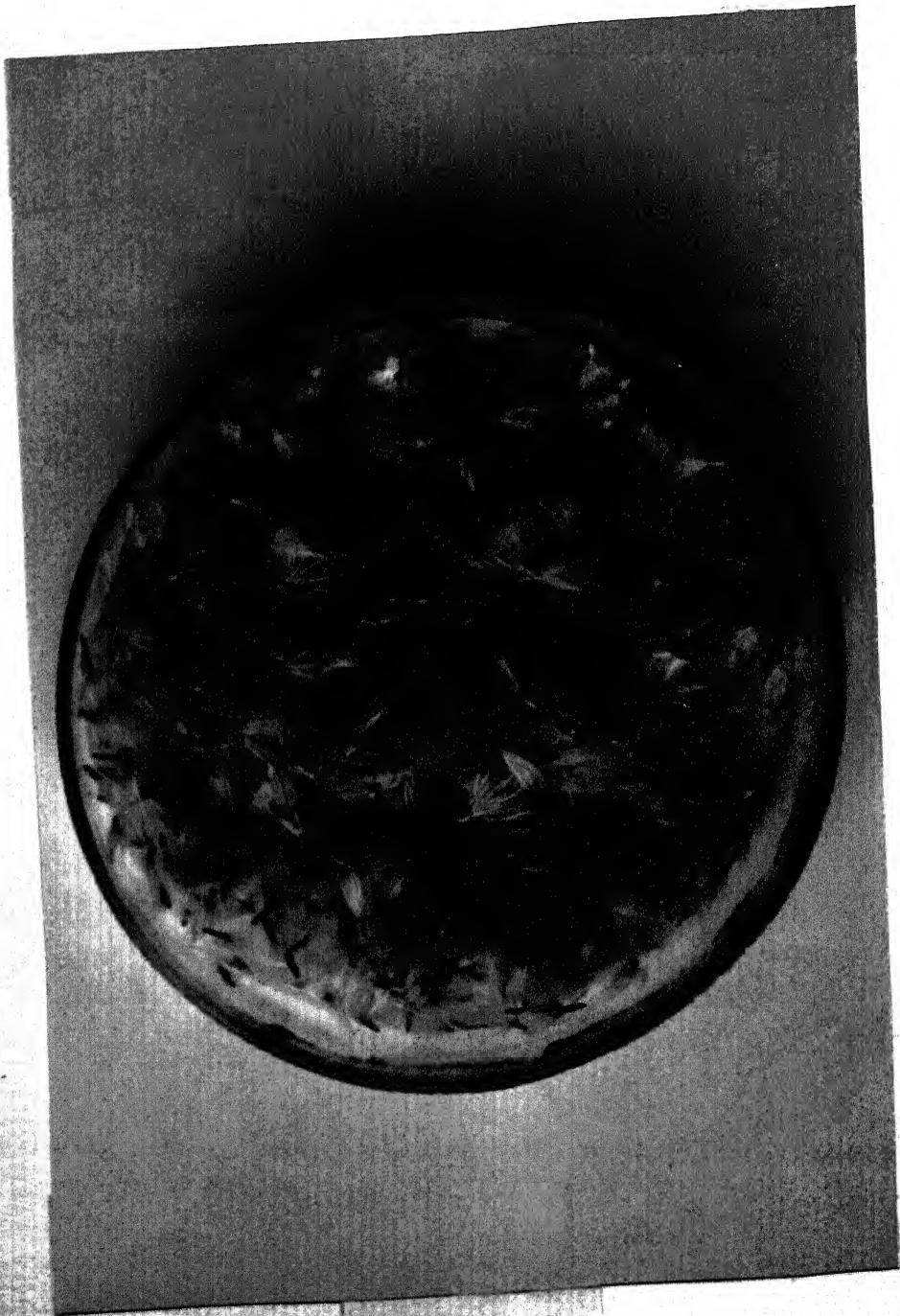


PLATE - XV

The size of forest tree seeds varies greatly. In *Terminalia arjuna*, the seed length was reported in the range of 18x8 mm (Dubey, 1991). The seed length of *Tectona grandis* was found to be 4.3 and breadth of 5.65 mm (Mishra, 1992).

The method of selection of seeds and their conversion into seedling have been described by Mandal *et al.* (1998). These methods are simple to use as selection of both strands and plant are done entirely on the basis of ocular observation.

In the present work, seeds were collected by two methods, these methods of seeds collection are similar as described by Tripathi, *et al.* 1984. Bhardwaj (1996) has also described details of seed collection and pre sowing and handling method.

Rai (1995) has described the ecological aspects of seed collection of *Shorea robusta* with reference to Uttar Pradesh. Lathal *et al.* (1996) has studied on the methods of seed collection and Nursery management in *Quercus semecarpifolia*.

More recently Chaturvedi (1998) and Yadav (2002) also described the various aspects of seed collection, with reference to many forest, tree and plant species.

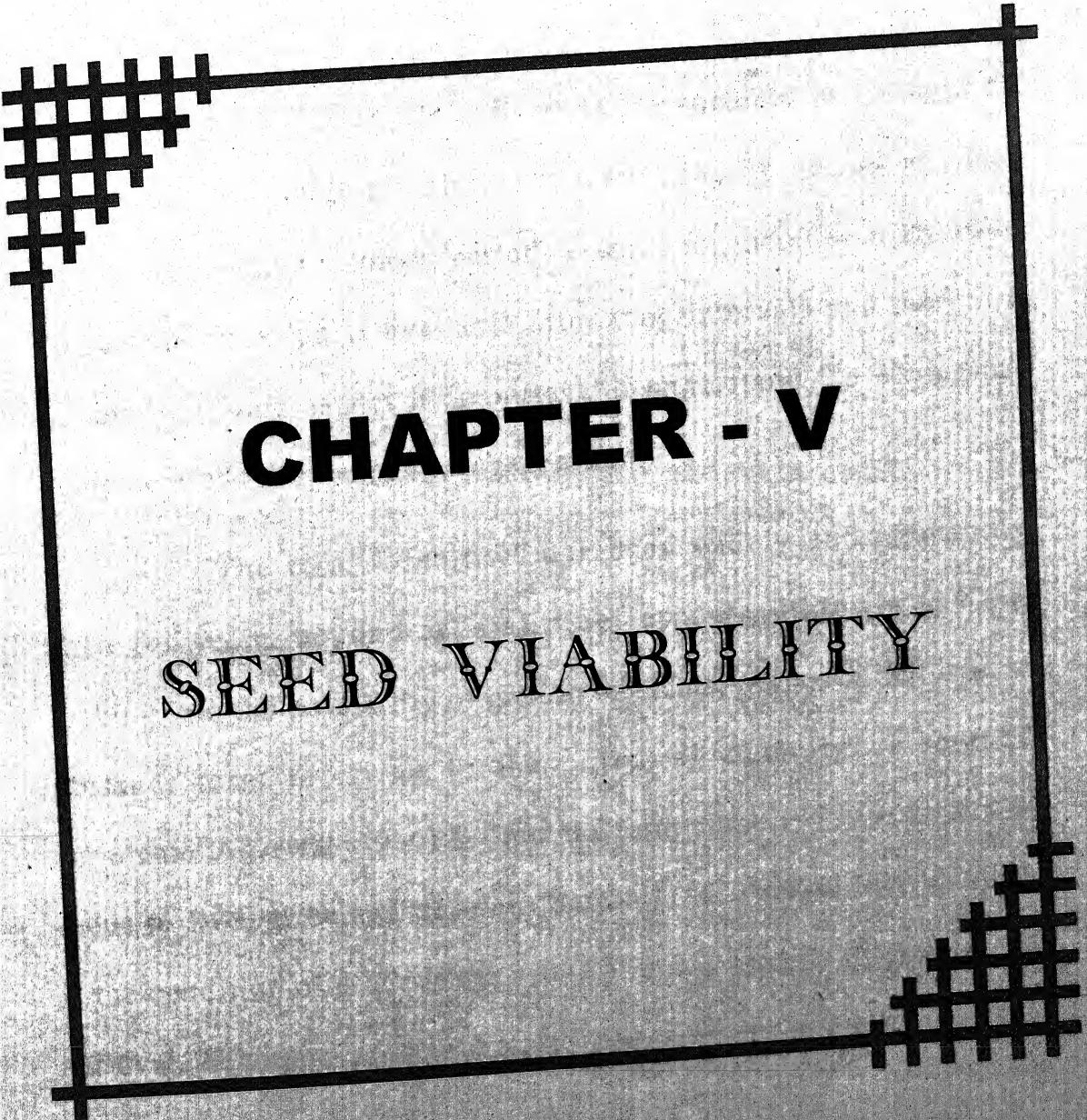
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CHAPTER - V

SEED VIABILITY

SEED VIABILITY

INTRODUCTION

Seed viability is defined as the capacity of the seed to remain capable of germination for some specific period of time. Viability of seeds for longer periods ensures regeneration even when favourable situation is available after long intervals and therefore the study of this aspect is important to understand the ecological equipment of the species for regeneration.

The term "viability" has been widely and repeatedly used for seeds beyond several other aspects. Baldwin (1942), looking into the possibility of growth of plants, proposed that it is an abstract term referring to the potential capacity of seed to germinate. Agarwal (1980) defined the term viability as the ability of seeds to live, grow and develop. Barton (1961) stated that viability is the condition of seeds in the sense of being capable of growth and survival. Schopmeyer (1974) stated that viability is the potentiality of seed to germinate.

Bonner (1984) defined seed viability as the state of being capable of germination and subsequently growth and development of the seedlings. Thus it can be said that a viable seed is one which is capable of germinating under proper circumstances.

Seed Viability : A Seed's Ability to Sprout and Grow

Much of seed viability depends upon storage conditions. The ideal storage condition for seeds is somewhere cool and dry. For many homeowners a capped jar in the refrigerator serves the purpose. Just looking at the seed will often give an indication of seed quality. For seed that are usually smooth and round or plump, will not germinate well if they are packed or wrinkled. Peas, Corn and many other seeds are normally wrinkled but may not look as good as they should.

When we discuss storing foods away for long periods of time we could be talking about two things:

1. Storing seed away to protect it's viability -

The science behind storing seeds for a long time in order to sprout them later is still somewhat in it's infancy. What's known is there's a lot of different criteria regarding storing different seeds for long term storage. It seems that every kind of seed has it's own unique criteria for long term storage. Some seeds store better in air. Others store better in nitrogen, and still other do better in a vacuum, carbon dioxide or argon. And others seem to be tolerant to all the different gases. But from studying the material in Handbook 506, two trends emerge for all seeds : temperature and moisture.

i) Temperature :-

Generally, the colder you store them, the longer the seed will remain viable. For really long storage - such as 5-10 years, it's best if you can keep them frozen. If this isn't an option for you, you should still store them as cool as possible. For example, it would be better to store them in your basement than in the pantry upstairs. And when winter arrives, it's not going to hurt things a bit, as long as your seeds remain below 10% moisture, to take them to the garage, barn or other outbuilding where they can remain frozen throughout the winter. Just remember to bring them in before the summer heat returns. The viability of your seed will be short lived in a 130 degree F outbuilding.

ii) Moisture :-

It is the other really big key factor. To get many years of viability out of seeds they need to be dry, generally drier than mother nature naturally gets them. Whereas 10% is acceptable for long term storage of seeds for eating, they should be dryer than this if you expect to get years and years out of them for viability. Four per cent moisture seems to be the magic number where extra drying gives no further advantage. Storing seed for long them storage in hot environments makes the

moisture content of the seed more critical. Tests seem to show that the higher the moisture content, the faster the seed's respiration rate. In my mind, increased respiration generally shows a lower state of suspended animation and shorter storage life. And again, temperature is closely linked with this.

2. Storing seed away to protect it's nutritional value -

The question sometimes gets ask, "Doesn't protecting seed for viability also automatically protect them the best for nutrient content and usability ?" The truth is, this isn't always the case, for example in beans. The data in Handbook 506 seems to say that it doesn't matter a great deal what the storage gas is for long term viability. Yet the outer shell of beans stored in air over several years lose their quality to soften up when cooked. However, these same "hard" beans will often sprout just fine. Removing all the oxygen will just about stop the seed's oxidation rate (although it only slows down the aging process) thus seed loses its viability.

The objects of quick viability tests are :

- (1) To determine quickly the viability of seeds of species with normally germination methods.
- (2) To determine the viability of samples which at the end of the germination test reveal a high percentage of fresh ungerminated or hard seeds.

The viability of a seed is governed by various factors such as:

- (a) Storage condition of the seeds.
- (b) Age of the seeds.
- (c) The atmosphere and the environmental conditions prevailing at the time of maturity or formation of the seeds.
- (d) Genetic constitution of seeds.

Seed Vigour :

The seed vigour denotes the degree of aliveness (Bonner, 1984). Seed vigour is the important attribute of seed quality. It is a common observation that many times a very poor and patchy crop results from the seeds showing high level of germination. Seed lots that are indistinguishable in terms of germination level might well be at different stages of deterioration. Thus, significant differences can be seen in the crop stand and yield raised from different seed lots having similar germination levels. It has often been observed that two seed lots of one particular kind or variety., having similar germination percentage, perform differentially under the field conditions, result into a good crop stand while the other crop fails to do so. This differential behaviour may be attributed to the stamina or the vigour of the seed. Seed forms the most important and cheapest input in modern agriculture.

Immature seed germinates slower and is required more in number than fully ripened seeds as a rule. Flemion (1931) has observed that some immature seeds are required less in number than mature ones. As per size and weight of seed, generally the heaviest seeds are the best, have the most reserves and germinates more promptly and produce the most vigorous seedling at the start. Older seeds germinates more slowly than fresh seed and contains a greater percentage of non-volatile or weak seed. Seeds from the vigorous parents have longer embryo than seeds from less healthy parents. Different colours of seeds also affect the seed germination with in a species.

The internationally accepted definition of seed vigour as proposed by Perry (1978) reads as under "Seed vigour is the sum total of those properties of the seed which determine the level of activity and performance of the seed or seed lot during emergence. Seeds which perform well are termed high vigour and those perform poorly are called low vigour seeds".

Seeds orthodox and recalcitrant have been classified on the basis of their response of water. The orthodox seeds are usually dormant and can retain their viability for a certain period even at very low moisture content. In the recalcitrant seeds reduction in moisture content below some critical value leads to the loss of viability (Roberts, 1973). Those seeds which exhibit little or no

dormancy, deteriorate rapidly on storage (Oborne, 1977) and cannot be stored at low temperature without injury (Harrington, 1973).

Both physiological and biochemical processes are essential for maintaining the viability of seeds and have been the subject of intense research during the past few decades. The seeds of Sal (*Shorea robusta* Gaertn. F.) are recalcitrant (Purohit, *et al.* 1982) and considerable work has been done to determine the cause of non-viability in these seeds.

Vigour Index :

For determining seed vigour tetrazolium or indigo carmine staining is used, as it is based on same principles as for determining speed viability. The main difference is that seed judged to be viable are further weak, dead or necrotic tissue of ten seeds and rating was done according to the possible influence of these tissues on subsequent performance in field or nurseries.

Frank (1950) suggested for the first time that viability and vigour tests should be separated and Isely (1957) gave a first clear concept of vigour by defining it as the sum-total of all seed attributes which favour stand establishment under unfavourable field condition. Thus, he gave two considerations :

- (1) Vigour per seed in terms of rapidity of germination and growth of seedlings.

(2) Susceptibility to unfavourable conditions.

ISTA (1976) defined vigour "the sum total of those properties of the seed which determine the potential level of performance and activity of a non dormant seed or seed lot during germination and seedling emergence".

One thing which became apparent was the fact that the vigour is not a single measurable property like germination (viability), but a concept describing several characteristics which are all associated with various aspects of performance of the germinating seed or subsequent seedling. Thus, vigour test were developed in subsequent years. Woodstock (1976) taking into consideration one or more seed/seedling attributes manifesting vigour.

Vigour Measurement :

A vigour test must be reproducible and the results must have been proved to be correlated with field performance characteristics, such as seedling emergence under environmental stress conditions.

A definite vigour test for practical purpose which can be subjected to all the crops, has not been standardized so far. The various methods used for measurements of seed vigour can be categorized into two groups:

(a) Direct methods

(b) Indirect methods

Direct method -

This method is considered to be more accurate than the indirect methods for vigour estimation. These methods are relatively simpler to follow. Some of the direct methods are as under:

i) **Field test :-**

Replicated seed lots are sown in the field and data on field emergence and final economic yield are noted. Since soil is a variable factor, care needs to be taken regarding the choice of field, for uniformity and randomisation for minimizing errors. Since final yield is dependent on many other factors besides vigour, field emergence may provide a more reliable assessment.

ii) **Stress test :-**

Even though the germination potential of different seed lots may be similar, their vigour differences are magnified much more under stress environment as compared to optimum conditions. The stress may vary in bringing out specific weakness in seedlings.

iii) Speed of germination :-

The simple measurements of the rate of germination of different lots under same environment may provide basic information about vigour. The first count data in testing has often been used as a guideline in the direction. The germination energy often calculated by counting the percentage of seed germinating and developing into normal seedling under optimum conditions within a specified period was also under consideration for quite sometime. However, there are many problems of slowly germinating seeds in a lot and the concept of coefficient of velocity of germination (CVG) developed as follows :

$$CVG = 100 \times (A_1 + A_2 + A_3 + \dots + A_x) / (A_1 T_1 + A_2 T_2 + A_3 T_3 + \dots + A_x T_x)$$

Where, A = The number of seedling and T = Time corresponding to A

iv) Seedling assessment :-

The rate of seedling growth under similar condition provide valuable indication of the inherent capacity of growth and development. Standardized method of seedling growth provide reliable results and is simple in operation. The first count and the dry weight of the seedling are also indicators of the growing capacity of seed lots.

v) **Seedling growth rate :-**

The lengths of ten arbitrarily selected normal seedlings/ replication is measured after taking the final germination count. Higher mean seedling length denotes greater seedling vigour. Perry (1977) developed the method and the equation for its measurement.

Indirect method -

i) **Vigour class :-**

Perry (1969) is the pioneer to establish a vigour test based on vigour classes of the seedlings. Overall assessment of pea seedlings was more useful in the vigour classes than only single linear measurement. Same year, Woodstock (1969) reported that measurement of seedling growth was useful to illustrate a definition of seed vigour which permitted a qualitative analysis of vigour in corn.

Seedling vigour classification was found to be significantly correlated with field emergence in soyabean seed by Yaklich and Kulik (1979). Cooper *et al.* (1980) compared seedling length on a particular day with speed of elongation (SE) as a criteria for estimating seedling vigour. McDonald Jr. (1980) has given emphasis on seedling classification test and suggested that this test gives close results of seed vigour.

ii) Vital staining procedure for seed vigour :-

Lakon's (1950) tetrazolium test provides an estimate of potential germination percentage and vigour of seed lots. Gadd (1953) verified it to be good indicator for seed vigour. Moore (1962) concluded that in the hand of a properly trained analyst, TTC test is highly useful diagnostic tool for the assessment of seed vigour. Mian and Coffey (1968) found that TTC test was a good method for determining seed vigour in *Zea mays* as was the cold test.

The best vigour index for emergence capacity of wheat (*Triticum aestivum*) embryos was the topographic method with tetrazolium, reported by Cseresnyes (1969). In a study on soyabean (*Glycine max*), Mukherji *et al.*(1971) found that the tetrazolium test gave significant correlations with both germination and vigour which they defined seedling survival. Perry (1981) has given the details of the T.T.C. test for seed vigour, which is now widely practiced by seed technologists.

Indigo carmine is another vital stain useful for estimating seed vigour. As tetrazolium involves detection of dehydrogenase present in living tissues, this vital stain is capable of distinguishing living from non-living necrotic tissues inside a germinating seed.

MATERIALS AND METHODS

In all the tests performed to assess viability and vigour of different forest tree seeds minimum 4 replicate of 100 seeds were taken and the results were expressed in term of mean values.

Assessment of Seed Viability :

The assessment of seed viability has been done by two tests.

1. Cutting test -

It is the most inexpensive test for testing viability in many countries. The simplest viability testing method is directly eye inspection of seeds. Seeds were imbibed in water for 24 hours and cut longitudinally in two halves with the help of scalpel. Cut halves were placed on glazed glass plates for further observation. The evaluation was done by naked eye to find out sound, empty and immature seeds in the sample. Healthy seeds has normal colour of endosperm and well developed embryo which had been considered viable and germinable or nongerminable. Seed without embryo or abortive embryo or with milky, mouldy, decayed, shrivelled, diseased or insect attacked is considered as non-viable (Bonner, 1974). Cutting test of some selected medicinal plant species is presented in table 5.1.

Table 5.1 : Cutting test of seeds of some selected medicinal plant species

Category	Percentage				
	<i>A.mexicana</i>	<i>B.diffusa</i>	<i>C.obtusifolia</i>	<i>D.metel</i>	<i>T.procumbens</i>
1. Healthy (good) pure seed	70.00	90.00	80.50	75.50	65.00
2. Other coloured seed/ cotyledon's seed	1.00	6.00	8.00	4.50	5.40
3. Damaged seed	13.00	2.00	2.50	16.00	19.60
4. Diseased/Insect infected	16.00	2.00	9.00	4.00	10.00

2. Biochemical test -

The biochemical test of seed viability was done by 2,3,5 triphenyl tetrazolium chloride and indigo carmine staining test. The preparation of ISTA (1985).

i) Working sample size :-

Each time 4 replicate of 100 seeds drawn in a random way from pure seed fraction after purity test.

ii) Premoistening of seeds :-

Premoistening is necessary to make the seeds soft enough to be decoted. Seeds were imbibed in water by placing between moistened filter paper for upto 8 hours (ISTA, 1976, Rule 6.5 2A). Hard coated seeds were scarified and the soaked in water. Moistened seeds were placed on filter paper to drain excess water. During this period, activation of enzymatic processes take place and the tissues become less fragile.

iii) Decoating of seeds prior to staining :-

Before immersion of seeds in the staining solution, seeds were exposed in air to allow easier penetration of tetrazolium/ indigo carmine stain and to facilitate evaluation. Seed coat was opened or removed using different techniques. Seeds were kept moist until the whole replicate was completed.

Seeds were bisected while still on the blotter with one clean sliding out with a sharp razor blade to expose the main structure of embryo. One half of each seed was immediately transferred from blotter to the staining solution with a razor, forceps or fingers in order to avoid drying.

In few cases where seed was swollen, seed coat was removed with the help of forcep, needle, blade, thumb, nail etc. Then seeds were placed on moistened filter paper.

iv) Preparation of staining solution :-

(a) 2, 3, 5 Triphenyl tetrazolium chloride (TZ) :

2, 3, 5 TTC is a light yellow, weter soluble powder. An aqueous solution of tetrazolium chloride of pH 6.5-7 was used. The conentration of solution from 0.1 to 1 percent according to the species.

It was necessary to buffer the solution to achieve the control pH range. The buffer solution was prepared as follows:

Solution 1- 9.078 g KH_2PO_4 dissolved in 1000 ml of water.

Solution 2- 11.876 g $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$ dissolved in 1000 ml of water.

400 ml of solution 1 and 600 ml of solution 2 were mixed and 2, 3, 5 triphenyl tetrazolium chloride was added to this buffer. 10 g of TTC powder was dissolved in 1000 ml of this buffer.

From this stock solution various dilutions were made. The stock solution was stored in an amber coloured glass bottle in dark at room temperature and was used for staining upto 6 weeks. Stain was kept in dark. Procedure of tetrazolium test is presented in table 5.2.

(b) **Indigo carmine solution (IC) :**

The 0.1 per cent solution of indigo carmine was prepared in distilled water. For staining of seed 1:1000 (w/v) indigo carmine was used (Nellijubov, 1929).

v) **Incubation :-**

Cut halve of seeds as prepared above was immersed in tertazolium solution in beaker. Covered beaker was incubated at 30°C in dark (ISTA, 1985). Incubation period was variable from species. After incubation, seeds were immediately washed with water, 2-3 times to drain the the excess dye. Seeds were then placed on glass plates for further evaluation.

Seeds were immersed similarly in indigo carmine solution, and incubated at 30°C for 1-2 hours. After incubation, seeds were rinsed with water to drain the excess indigo carmine solution. The procedure of indo carmine test is presented in table 5.2.

Table 5.2 : Procedure of Tetrazolium (TZ) and Indigo Carmine (IC) Test

Name of Species	Scarified or not	Premoistening Type	Time (hr)	Staining at 30°C		Staining periods (hr)	
				TZ	IC	TZ	IC
<i>A. mexicana</i>	No	BP.	12	0.1	0.1	4	1
<i>B. diffusa</i>	No	W	12	0.1	0.1	5	2
<i>C. obtusifolia</i>	Yes	W	24	0.1	0.1	5	2
<i>D. metel</i>	No	W	12	0.1	0.1	5	2
<i>T. procumbens</i>	No	BP.	12	0.1	0.1	4	1

vi) Evaluation of staining pattern :-

(a) Tetrazolium staining :

Stained seeds were placed in glazed glass plate under a dissecting microscope for examination. Evaluation was done as per Rule 6.5, 2A.4 (ISTA, 1985). All essential structures such as meristems and embryo were examined carefully for staining. Seed weakly stained embryo with non-stained essential structures was considered non-viable (Leadem, 1984). Seeds were classified into different categories on the basis of degree of staining pattern.

(b) Indigo carmine staining :

Stained seeds were arranged in a row on a white plate for examination of degree of colouration under a dissecting microscope. 5-6 groups were recognized for evaluation (Baldwin, 1942).

Assessment of Seed Vigour :

Assessment of seed vigour has been carried out by three methods : (1) Staining method, (2) Measurement of germination velocity index (GVI) and (3) Seedling formation method.

1. Staining method -

Procedure used for tetrazolium and indigo carmine test to determine seed vigour was same as applied for viability test

except that viable seeds were further classified into vigour categories. This classification was made on the basis of colours received by seed embryo at various locations (table 5.2).

2. Seedling formation method -

Seeds of all five plant species were kept for germination. Germination media for these species are different, i.e. laboratory and soils. In laboratory towel paper, silica sand and artificial growth media kept in the germination incubator at 30°C temperature. In soil, sand, red soil, black cotton soil etc. spacing between seeds was uniform and enough apart to prevent the coming up seedlings from touching each other. Two hundred seeds of each species were taken for evaluation of germination percentage. One replicate was taken for the study of seedling vigour classes.

From each species, seedling were classified into six vigour classes according to their growth performance. Classified seedling were separated daily into their vigour classes. Abnormal seedlings were not included at all, but however their number was included in the calculation of percentage germination and Germination Velocity Index (GVI), (Babey and Kandya, 1939b, 1984b).

Duration of test and seedling evaluation varied according to species. Counting and evaluation of seedling was done upto 14 days for all four forest tree species.

Six vigour classes of seedlings were the same in their length, shape and overall size in all species. Redicle 4 times longer than seed was granted to evaluate seedling as normal. Other structures (e.g. epicotyl, cotyledons) if appeared without the elongation of seedling, were not taken into consideration and seedling as a result of polyembryony (Adarsh Kumar *et al.*, 1977; Dabral, 1977; Kulkarni and Srimati, 1981; Purohit and Jamaluddin, 1988 and Shrivats and Bajpai, 1988), counted a single seed in the germination test.

Seeds of all the five plant species, which were stored variously, and were tested for their germination in the laboratory as well as in the soils.

3. Measurement of germination velocity index (GVI) -

During germination of seeds in the laboratory and soils, daily counts of the newly germinated seeds were made until germination completed.

GVI was calculated by -

Daily counts

Number of days of germination

$$GVI = \frac{X_1}{1} + \frac{X_2}{2} + \frac{X_3}{3} + \frac{X_4}{4} + \dots + \frac{X_{14}}{14} = N$$

Higher values of GVI, represents vigorous seedlot of the species.

RESULTS AND DISCUSSION

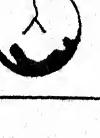
Results of vital staining test are given in table 5.2. Two vital stains Indigo-Carmine and Tetrazolium Chloride have been tried on the seeds of selected medicinal plants species viz. *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. It is interesting to note that indigo-carmine stains only dead tissue of the embryo while tetrazolium stained only living tissue of the seed.

The result of viability and cutting test are presented in Table 5.1. These results are usually much closer in the case of fresh seeds (Tomey and Stevens, 1928). Seeber and Agapoa (1976) found correlation between cutting test and germination test in relatively large seed species.

On the basis of tetrazolium chloride staining pattern, seeds have been classified into different classes.

Stained seed including both cotyledon and embryo were classified in class I, similarly 8 categories were made in all the selected plant species. Percentage of seed belonging to a particular category were compared with the seed germination and actual germination in laboratory. It was noted that staining is comparable with tetrazolium staining up to 4 categories only (table 5.3, 5.4, 5.5, 5.6, 5.7).

Table 5.3 : Tetrazolium staining pattern in seeds of *Angemone mexicana* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both stained.	32.12	+	Very Fast	
2.	Embryo and cotyledon stained except some portion of cotyledon.	19.31	+	Fast	
3.	Embryo and more than 50% portion of cotyledons stained.	14.35	+	Slow	
4.	Embryo and cotyledon stained except tip of radicle.	12.3	+	Very Slow	
5.	Embryo stained but cotyledon stained in patches	2.87	-	No Growth	
6.	Embryo and cotyledon unstained.	4.91	-	No Growth	
7.	Embryo fungal attacked.	11.00	-	No Growth	
8.	Embryo cotyledon insect attacked.	9.10	-	No Growth	

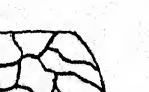
F= Frequency. V= Viability Vi= Vigour

Table 5.4 : Tetrazolium staining pattern in seeds of *Boerhaavia diffusa* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both stained.	23.68	+	Very Fast	
2.	Embryo and cotyledon stained except some portion of cotyledon.	12.21	+	Fast	
3.	Embryo and more than 50% portion of cotyledons stained.	3.94	+	Slow	
4.	Embryo and cotyledon stained except tip of radicle.	6.23	+	Very Slow	
5.	Embryo stained but cotyledon stained in patches.	15.1	-	No Growth	
6.	Embryo and cotyledon unstained.	2.28	-	No Growth	
7.	Embryo fungal attacked.	10.00	-	No Growth	
8.	Embryo cotyledon insect attacked.	12.95	-	No Growth	

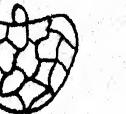
F= Frequency. V= Viability Vi= Vigour

Table 5.5 : Tetrazolium staining pattern in seeds of *Cassia obtusifolia* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both stained.	31.17	+	Very Fast	
2.	Embryo and cotyledon stained except some portion of cotyledon.	21.71	+	Fast	
3.	Embryo and more than 50% portion of cotyledons stained.	13.15	+	Slow	
4.	Embryo and cotyledon stained except tip of radicle.	8.95	+	Very Slow	
5.	Embryo stained but cotyledon stained in patches.	7.61	-	No Growth	
6.	Embryo and cotyledon unstained.	9.15	-	No Growth	
7.	Embryo fungal attacked.	6.17	-	No Growth	
8.	Embryo cotyledon insect attacked.	6.10	-	No Growth	

F= Frequency. V= Viability Vi= Vigour

Table 5.6 : Tetrazolium staining pattern in seeds of *Datura metel* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both stained.	31.14	+	Very Fast	
2.	Embryo and cotyledon stained except some portion of cotyledon.	16.10	+	Fast	
3.	Embryo and more than 50% portion of cotyledons stained.	6.13	+	Slow	
4.	Embryo and cotyledon stained except tip of radicle.	5.0	+	Very Slow	
5.	Embryo stained but cotyledon stained in patches.	7.91	-	No Growth	
6.	Embryo and cotyledon unstained.	8.00	-	No Growth	
7.	Embryo fungal attacked.	10.10	-	No Growth	
8.	Embryo cotyledon insect attacked.	12.12	-	No Growth	

F= Frequency. V= Viability Vi= Vigour

Table 5.7 : Tetrazolium staining pattern in seeds of *Tridax procumbens* with viability and vigour

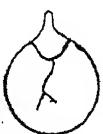
No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both stained.	15.50	+	Very Fast	
2.	Embryo and cotyledon stained except some portion of cotyledon.	13.25	+	Fast	
3.	Embryo and more than 50% portion of cotyledons stained.	6.7	+	Slow	
4.	Embryo and cotyledon stained except tip of radicle.	3.95	+	Very Slow	
5.	Embryo stained but cotyledon stained in patches.	2.35	-	No Growth	
6.	Embryo and cotyledon unstained.	1.97	-	No Growth	
7.	Embryo fungal attacked.	11.25	-	No Growth	
8.	Embryo cotyledon insect attacked.	21.51	-	No Growth	

F= Frequency. V= Viability Vi= Vigour

Indigo-Carmine staining (table 5.8, 5.9, 5.10, 5.11, 5.12) were also interpreted on the basis of seed staining patterns. In this case seed with little or no staining were placed in most viable categories and other staining classes were made on the basis of increased in percentage staining of the seed. Viable staining categories with the laboratory and field germination were compared and found to be significant classes of higher (I to IV) categories. On the basis of present observation data shows that in all seeds viability can be tested and these were found reliable when compared with laboratory germination. When I compared the Tetrazolium and Indigo-carmine test, results indicated that both tests are useful, however occasionally higher viability estimation may result with T.Z. (Simak and Kamara, 1963).

During present investigation all the selected plant species showed higher viability. Similar variations were observed when the seed viability was evaluated by indigo-carmine staining. The results are comparable with actual germination due to penetration of stain in seed (Flemion and Poole, 1948, Vincent 1957). Relative penetration of stain depends on the membrane integrity of seed and enzyme concentration. On the basis of present investigation, it can be concluded that I.C. is superior over T.Z. staining as it is less time consuming. The stain is not damaged due to light and has good solubility and can be stored for long duration

Table 5.8 : Indigo carmine staining pattern in seeds of *Argemone mexicana* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both unstained.	31.32	+	Very Fast	
2.	Embryo and cotyledon unstained except some portion of cotyledon.	7.6	+	Fast	
3.	Embryo and more than 50% portion of cotyledons unstained.	2.21	+	Slow	
4.	Embryo and cotyledon unstained except tip of radicle.	3.12	+	Very Slow	
5.	Embryo stained but cotyledon unstained in patches	6.12	-	No Growth	
6.	Embryo and cotyledon stained.	5.71	-	No Growth	
7.	Embryo fungal attacked.	7.00	-	No Growth	
8.	Embryo cotyledon insect attacked.	21.10	-	No Growth	

F= Frequency.

V= Viability

Vi= Vigour

Table 5.9 : Indigo carmine staining pattern in seeds of *Boerhaavia diffusa* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both unstained.	19.32	+	Very Fast	
2.	Embryo and cotyledon unstained except some portion of cotyledon.	6.21	+	Fast	
3.	Embryo and more than 50% portion of cotyledons unstained.	4.31	+	Slow	
4.	Embryo and cotyledon unstained except tip of radicle.	3.00	+	Very Slow	
5.	Embryo stained but cotyledon unstained in patches	6.1	-	No Growth	
6.	Embryo and cotyledon stained.	5.71	-	No Growth	
7.	Embryo fungal attacked.	6.19	-	No Growth	
8.	Embryo cotyledon insect attacked.	11.10	-	No Growth	

F= Frequency. V= Viability VI= Vigour

Table 5.10 : Indigo carmine staining pattern in seeds of *Cassia obtusifolia* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both unstained.	31.00	+	Very Fast	
2.	Embryo and cotyledon unstained except some portion of cotyledon.	15.17	+	Fast	
3.	Embryo and more than 50% portion of cotyledons unstained.	12.13	+	Slow	
4.	Embryo and cotyledon unstained except tip of radicle.	3.17	+	Very Slow	
5.	Embryo stained but cotyledon unstained in patches	2.25	-	No Growth	
6.	Embryo and cotyledon stained.	1.97	-	No Growth	
7.	Embryo fungal attacked.	13.00	-	No Growth	
8.	Embryo cotyledon insect attacked.	18.00	-	No Growth	

F= Frequency. V= Viability Vi= Vigour

Table 5.11 : Indigo carmine staining pattern in seeds of *Datura metel* with viability and vigour

No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both unstained.	33.68	+	Very Fast	
2.	Embryo and cotyledon unstained except some portion of cotyledon.	11.52	+	Fast	
3.	Embryo and more than 50% portion of cotyledons unstained.	3.94	+	Slow	
4.	Embryo and cotyledon unstained except tip of radicle.	15.1	+	Very Slow	
5.	Embryo stained but cotyledon unstained in patches	7.32	-	No Growth	
6.	Embryo and cotyledon stained.	3.76	-	No Growth	
7.	Embryo fungal attacked.	2.81	-	No Growth	
8.	Embryo cotyledon insect attacked.	12.95	-	No Growth	

F= Frequency. V= Viability . Vi= Vigour

Table 5.12 : Indigo carmine staining pattern in seeds of *Tridax procumbens* with viability and vigour

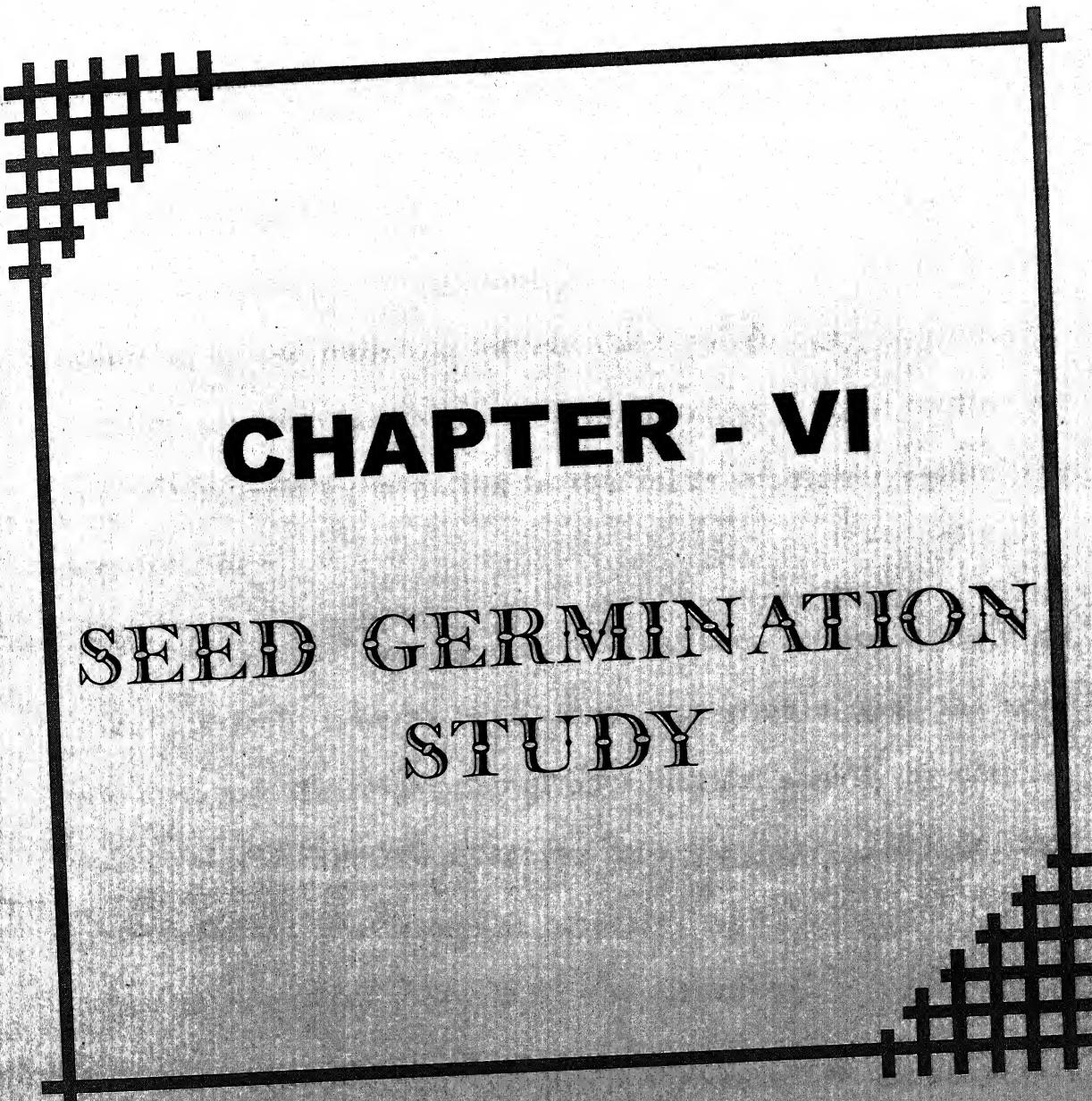
No.	Category	%F	V	VI	Staining pattern
1.	Embryo and cotyledon both unstained.	12.36	+	Very Fast	
2.	Embryo and cotyledon unstained except some portion of cotyledon.	11.19	+	Fast	
3.	Embryo and more than 50% portion of cotyledons unstained.	5.65	+	Slow	
4.	Embryo and cotyledon unstained except tip of radicle.	9.25	+	Very Slow	
5.	Embryo stained but cotyledon unstained in patches	21.31	-	No Growth	
6.	Embryo and cotyledon stained.	11.67	-	No Growth	
7.	Embryo fungal attacked.	9.75	-	No Growth	
8.	Embryo cotyledon insect attacked.	17.50	-	No Growth	

F= Frequency. V= Viability Vi= Vigour

of time. The seeds were evaluated after a storage of 12 months at room temperature.

Seed viability determined by tetrazolium chloride test by various workers showed good relationship with viability and germination Mukherji (1956), Unalcin (1979), Kandya and Babeley (1984), Moore (1985). Buszewicz and Holmes (1957) considered embryo with about 1/6 of the unstained area as viable. This appears to be correct in many cases, but the area at which necrosis occurs in embryo also seems to be of significance. In view of the above findings the results of the present study can be interpreted. Lakon (1950) also emphasized the importance of necrosis on the endosperm in the tetrazolium test. Bulat (1957) considered those seeds viable which were having completely stained embryo and endosperm. Further, most of the seeds contained completely stained embryo and endosperm. Further, most of the seeds contained decisive tissue, which has ability to repair small superficial necrosis of limited extent even within, "Decisive tissue", (ISTA, 1983). Neljubov (1925) studied that the indigo carmine stains dead or dying tissue of the embryo readily but leaves the living issue unstained. From the degree of staining of embryo, the germination capacity of the seed has been estimated during the course of the present investigation. Saha *et al.* (1995) have reported several factors for the short viability period of the seed of *Shorea robusta*. In present

investigation, the status of the viability period of the seeds stored for 12 months at room temperature is reported. Similar results have also been obtained Yadav *et al.* (1988) in the seeds of *Chloroxylon swietenia* (Bhirra). They have determined seed viability by tetrazolium and indigo-carmine staining.



CHAPTER - VI

SEED GERMINATION STUDY

SEED GERMINATION STUDY

INTRODUCTION

The term germination is used to refer to a fairly large number of processes, including the germination of seeds and of spores of bacteria, fungi and ferns as well as the processes occurring in the pollen grain when the pollen tube is produced. Although all these are processes of germination, we will confine the use of the term germination to the seeds of higher plants, the Angiosperms.

Similarly seed germination has been defined by different scientists from time to time. In a very simple way, the seed germination is the resumption of physiological activity by dormant embryo inside the seed. Mayer and Mayber (1963) defined germination as "that group of processes which cause the sudden transformation of dry seed into the young seedling".

Seed germination in nature is regulated by the number of factors. Some of the basic requirements for seed germination are adequate supply of water, suitable temperature and composition of the gases in the atmosphere and light for certain seeds. Seed germination is only accomplished if net resultant conditions after

interaction of all physical, chemical and biological factors are in favour of seed.

Seed is defined in oxford dictionary as "Flowering plant unit of reproduction (especially in the form of grain) capable of developing into another such plant". Other workers defined this from time to time in different ways with more or less similar sense. A famous biologist once said that a seed is the greatest miracle ever created by nature. This appears to be true for such tree species like *Ficus bengalensis*, in which seed like a pin head in its appearance, and it is capable of producing the huge tree of several tons.

Some important contributions on ecological and physiological aspects of seed and seed germination were made by Fowells (1953). Evenary (1956) suggested that seed germination consists of the following phenomenon :

- (1) Absorption of water (mainly by imbibition) through the micropilar region of seed and some time by seed coat.
- (2) Enzymatic activity increased the respiration and assimilation rates, which directly indicate the use and translocation of stored food to the growing region.
- (3) Cell enlargement and cell division resulting in emergence of root and plumule growth.

Quality seed is the significant input in all crop production programmes. The value of pure seed can hardly be over emphasised. The viability and germination are important factors which control the vigour of seedlings in the nursery. Progressive decrease in germination of stored seeds have been observed in studies conducted elsewhere (Khan, 1977).

The height, girth, number of leaves and branches are the most important morphological characters which contribute to seedling vigour in different species in the nursery. The vigour of seedlings in the nursery depends on overall growth behaviour of these characters. The purpose of present study is to estimate the germination behaviour of seeds of 5 different medicinal plant species. The study also aims to investigate the various growth pattern of seedling in the nursery and to work out the correlation trends between the shoot and root growth parameters.

According to Sahu *et al.* (1995) orthodox and recalcitrant seeds have been classified on the basis of their response of water. The orthodox seeds are usually dormant and can retain viability even at very low moisture content.

Imbibition :

Imbibition of seed is an introductory and the most decisive step moisture absorption in seed has been the subject of

wide spread investigations. While ample supply of water is essential for germination, excess soaking is frequently injurious. Kidd and West (1918, 1919) found that soaking of seed has a profound effect on the subsequent growth of the plant. Toumey and Durland (1923) studied, soaking effects on a number of coniferous seeds of upland species before sowing and found that soaking for more than 3 to 5 days were generally injurious. Resciher (1941) studied that injurious effect of presoaking of seed of soybean has been attributed to higher water permeability.

Orphan and Heydecher (1968) suggested that soaking injury is caused by deficient oxygen supply to the interior of the soaking seed because during soaking the cavity between the cotyledons if flooded with excess of water. Ghosh *et al.* (1974) studied that soaking of seed for 18 hours at room temperature is best treatment in *Pinus patula*.

The best imbibition time for germination is studied by Yadav and Mishra (1982). Marunda (1990) reported that H_2SO_4 rendered the seed coat soft ening causing uniform inflow of water and unrestricted expansion of embryonic parts thus leading to increase in rate and percent germination.

Temperature :

The germination percent was greatly influenced by temperature. Gupta and Kumar (1977) studied the effect of temperature and moisture on germination of *Dendrocalamus strictus* and reported that 30°C temperature and 50-75% moisture level was optimum for better germination. In a separate study they also reported that in *Dalbergia sissoo* seeds placed at room temperature of 20°C between germination (Towel) paper showed better germination.

Light :

The growth of seedling is influenced by light intensity and light quality. Light is the only source of energy which is fixed by them in the form of chemical energy by photosynthetic carbon assimilation for use in various life processes. During the early phase of life, many plant species are shade loving or light demanding. The influence of light intensity and light quality on the growth of plants is studied by Shirley (1929). Loach (1957) has worked out the shade tolerance in tree seedlings. Roberts (1971) found that in red oak (*Quercus rubra* Linn.) the tallest seedlings grew in 30% light. Pathak *et al.* (1983) studied the seedlings raised under 45% light condition showed better height and total dry matter in *Leucaena leucocephala* Linn.

Higher biomass production was observed in plants grown in full sunlight rather than that of shade plants. The total biomass production was maximum in *Terminalia arjuna* when compared with other species grown in both high and low light intensities, while the total biomass production of *Dolichandrone atrovirens* was minimum and other species were in intermediate position between *Terminalia arjuna* and *Dolichandrone atrovirens*. Gill (1994) has studied the effects on seeds in infra-red light. Wassink and Stolwijk (1956) have also reported that infra-red light was important for germination as it controls the hormones responsible for plant germination.

The influence of light has a great significance on the growth of seedlings as it is the only source of energy which is fixed by them in the form of chemical energy by photosynthetic carbon assimilation for use in various life processes. Many plant species are shade loving or light demanding during their early phase of life. The researches on this important aspect have been done by many investigators.

According to Chaturvedi and Bajpai (1999) the effect of different light conditions on germination and seedling growth of some selected forest tree species viz. *Bridelia retusa* (Spreng.), *H. antidysenterica* (Wall), *L. parviflora* (Roxb.) and *W. tinctoria* (R. Br.). Seeds were sown in earthen pots filled with a mixture of

garden soil, sand and decomposed manure in 2:1:1 ratio. After sowing of seeds, three light conditions viz. semi-shady, shady and full sunlight were considered for the experiment and observations were made at definite intervals. The above studies showed that root length was maximum under semi-shady condition in *B. retusa* and *H. antidyseterica* while in *L. parviflora* and *W. tinctoria* it was maximum in full sunlight. Root/shoot ratio was highest under shady condition in *H. antidyseterica*, *L. parviflora* and *W. tinctoria* respectively. The growth of seedlings of *B. retusa* and *H. antidyseterica* was better in semi-shady condition and in *L. parviflora* and *W. tinctoria* was higher in full sunlight conditions.

Tiwari *et al.*(2000) studied the effect of different light conditions on seedling growth of some leguminous forest tree species.

Potting Media :

Joshi (1960) studied the effect of soil type on the growth of *Anogeissus latifolia*. Better growth performance of *Tectona grandis* seedlings in black soil is studied by Yadav *et al.* (1982).

The deficiency or excess of any element in potting mixture may cause adverse effect on the growth of the seedlings. Srivastava *et al.* (1998) reported the selection of proper potting

mixture for raising *Acacia nilotica* seedlings under root trainer seedling production system. Ginwal *et al.* (2001) studied the effect of potting media for raising *A. nilotica* seedlings and concluded that in respect of sand, soil and compost, combination of sand and compost in the ratio of 1:4 (20% sand + 80% compost) produced the best results and scored maximum points in respect of quality parameters. Testing the organic ingredients, combination of charcoals and compost in the ratio of 1:4 (20% charcoal + 80% compost) was another good growing medium. Thus two potting mixtures with different ingredients were standardized. The results on use of pure compost as a potting medium were not very much appreciable. The compost is required to be supplemented with 20% charcoal or 20% sand for making it more effective in raising *Acacia nilotica* seedlings. Improper choice of potting mixture may result in poor quality seedling production in nurseries.

Hormone :

Hormone play an important role in seed germination. Germination studies of such economically useful species need priority attention to include them in plantation programmes. Seed dormancy is a major constraint faced by nursery operators who wish to have large uniform crops of seedlings. The problems are more severe for hard seed coat species. Thus enhancing germination by treating seeds with acids or scarification of seed coat to break

dormancy is having physiological and practical importance (Kramer and Kozlowski, 1979). The effect of growth regulators on seed germination of 20 species of forest plants was studied by Baines (1980).

Singh and Nayyar (2000) described the application of Gibberellic acid and Indole-3-Butyric acid to seed of aged bamboo (*Dendrocalamus hamiltonii L. Hungro*).

Ficus auriculata and *F. glomerata* have been reported higher stem cutting sprouting when treated with IAA and IBA (Dhyani and Khali, 1993). Idu and Omonhinmin (1997) studied the effect of acid pre-treatment on germination and seedling development of *Dichrostachys cinerea* (L.).

MATERIALS AND METHODS

Seed germination and seedling growth study of selected medicinal seeded plant species viz., *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens* was done considering storage, seed size and weight, moisture, temperature, imbibition, light, potting media and growth hormone treatments.

Working Sample :

For the germination studies sound seeds were sterilized by keeping them in 0.1% $HgCl_2$ for five minutes for the removal of

external microflora. Germination was recognized with the emergence of radicle above the soil surface or with the appearance of radicle. The observations were taken daily upto 20 days.

1. Storage -

Seeds were stored in sealed polythene bags at room temperature and also stored in sealed desiccators and partial vacuum was created with rotatory vacuum pump "Gevivek Compressor of 1/4 HP at 28" Hg.

2. Imbibition -

Two replicats of 100 seeds of each species were placed in distilled water for 8 hours at room temperature. After completion of imbibition period, seeds were placed in germination petridishes on the sterilized and moistened filter papers in seed germinator, at a temperature of $25 (\pm 3)^\circ\text{C}$. Observations were recorded daily for twenty days. Germination percentage and plant percentage were calculated after 20 days.

3. Moisture content -

After seed collection, seed moisture content was determined. Determination was carried out in triplicate on three independently drawn samples for each species. With the help of

analytical balance seed weight was determined. Seeds were kept inside the paper packets in an oven at constant temperature of 80 (± 2)°C for 24 hours, cooled in desiccator and reweighed. Moisture content was calculated and expressed as follows :

$$\text{Moisture Content (\%)} = \frac{\text{Fresh weight} - \text{Oven dry weight}}{\text{Fresh weight}} \times 100$$

4. Temperature -

Studies on the effect of temperature on seed germination was done by fixing the temperature of seed germinator at different constant temperatures of 20°C, 25°C, 30°C and 35°C.

5. Light Conditions -

To observe the effect of different light conditions on the seed germination and seedling growth, the experiments were performed in Botanical Garden, D.V. Postgraduate College, Orai. Selected healthy seeds were sown in earthen pots under three different light conditions i.e (I) Full sunlight, (II) Semi-shady or under tree canopy and (III) Shady or diffused sunlight for the experiment. After sowing all the pots were first kept under tree canopy for 20 days as semi-shady conditions which were thought to be essential for the establishment of seedling during early phases (Troup 1921; Tripathi 1984). There after five pots (in each case) were shifted in full sunlight in semi shady and in shady conditions

providing them approximately 100, 45 and 20 percent light respectively. Regular watering was done to these sets to provide sufficient moisture level.

6. Potting media -

Black soil and one month old saw dust were used to prepare following three media :

- (1) 100% soil
- (2) 50% soil and 50% sand
- (3) 50% soil and 50% saw dust.

Fifty seeds were sown in pots with five replicates. They were placed under the tree canopy and sufficient watering was done daily to keep them moist.

7. Hormone treatment -

Six month old seeds of all the test species were soaked in different concentrations (1 ppm, 2 ppm, 5 ppm, 10 ppm, 20 ppm and 100 ppm) of different chemicals viz., Indole-3 acetic acid, Indole-3 butyric acid and Gibberellic acid for 24 hours then kept for germination on moistened filter papers.

8. Germination test -

Germination trials of fresh as well as stored seeds were conducted simultaneously in the laboratory and in the nursery. Fifty

seeds from the each plant species were placed on filter paper in the "YORCO" seed germinator at $25 \pm 3^{\circ}\text{C}$. Watering was done in all petridishes to keep filter paper moist. Number of germinating seeds was recorded daily at a fixed time. Seedling length was noted when the seedling became 20 days old. Average values of 10 seedlings were taken into consideration for determining vigour index value etc. Similar samples of seeds were sown in earthen pots having a potting mixture of soil, sand and farm yard manure in 2:1:1 ratio. Pots were kept in the botanical garden where temperature varied from 15°C to 45°C in different seasons. Watering was done daily at a fixed time and germinating seeds were also counted daily.

Vigour Index (V.I.) :

This value is a multiple product of two factors that is average percentage germination and average length of seedling after a specific period. The following formula was used to calculate vigour index value.

$\text{V.I.} = \text{Average percentage of germination} \times \text{Average length of 20 days old seedling.}$

The germination capacity of a seedlot and length of a seedling of two different aspects i.e. seed vigour and vigour index represent the overall gain from a seedlot, very appropriately.

Seed Mortality :

When the germination test goes on, some of the seedlings die due to a number of causes. Such seedlings are normally weak and their rate of growth is also very slow. These seedlings do not withstand adverse environmental conditions, and bacterial and fungal attacks. Thus, the total number of dead seedlings at the end of germination test (after 30 days) were recorded and presented as percent seedling mortality.

Plant Percent :

At the end of germination test, the total number of surviving seedlings was noted and denoted as plant percent (seedling survival percentage) of a seedlot. It was calculated by the following formula :

Plant Percentage = Average percentage germination - Average percentage seedling mortality.

This value has a great significance in the field. In any plantation programme the total number of seedlings potential for becoming a mature plant is indicated by it. Thus, it helps nurserymen to calculate the actual amount of seeds to be used for obtaining a specific number of seedlings for any afforestation programme.

RESULTS AND DISCUSSION

The present study mainly concerned with the germination of seed of medicinal plant particularly in the influence of different environmental conditions, so that a ideal set of conditions can be presented for the cultivation practices of medicinal plants. Different factors such as storage period, temperature, potting media, light conditions which influence the germination of seeds are studied.

Germination is the process of conversion of seed into seedling, which involves different sequential series of morphogenetic event. Thus embryo eventually is converted into seedling. During this whole process different factors affect at one or many steps of the process. Germination starts with imbibition of seeds and ultimately development of seedling.

Plates 16, 17, 18, 19 and 20 represent the performance of germinated seeds after 7 days for all the selected plant species.

Storage period of seeds before germination affect the germination percentage of seeds which is shown in table 6.1 (fig.7) for the five selected species i.e., *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens*. A careful perusal of this table reveals that the germinability of seeds of all five species exhibits a trend of sharp decline at room temperature with increase in the storage period from fresh seeds to 12 months old seeds. The percent germination was found 95% in

PLATE- XVI : Showing *Argemone mexicana* - Germinated seeds
after 7 days



PLATE - XVI

PLATE- XVII : Showing *Boerhaavia diffusa* - Germinated seeds
after 7 days

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PLATE - XVII

PLATE- XVIII : Showing *Cassia obtusifolia* - Germinated seeds
after 7 days



PLATE - XVIII

PLATE- XIX : Showing *Datura metel* - Germinated seeds
after 7 days

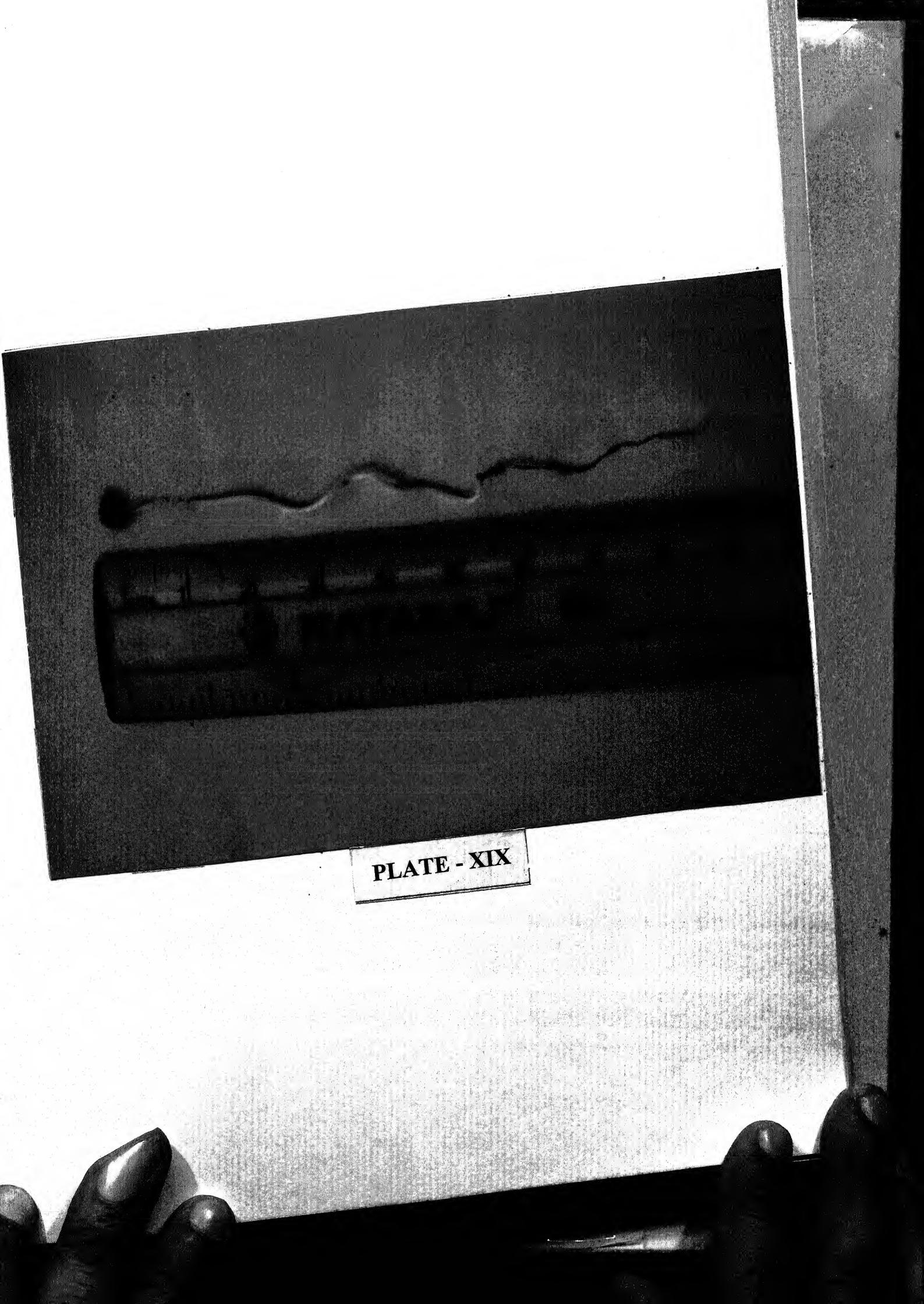


PLATE - XIX

PLATE- XX : Showing *Tridax procumbens* - Germinated seeds
after 7 days

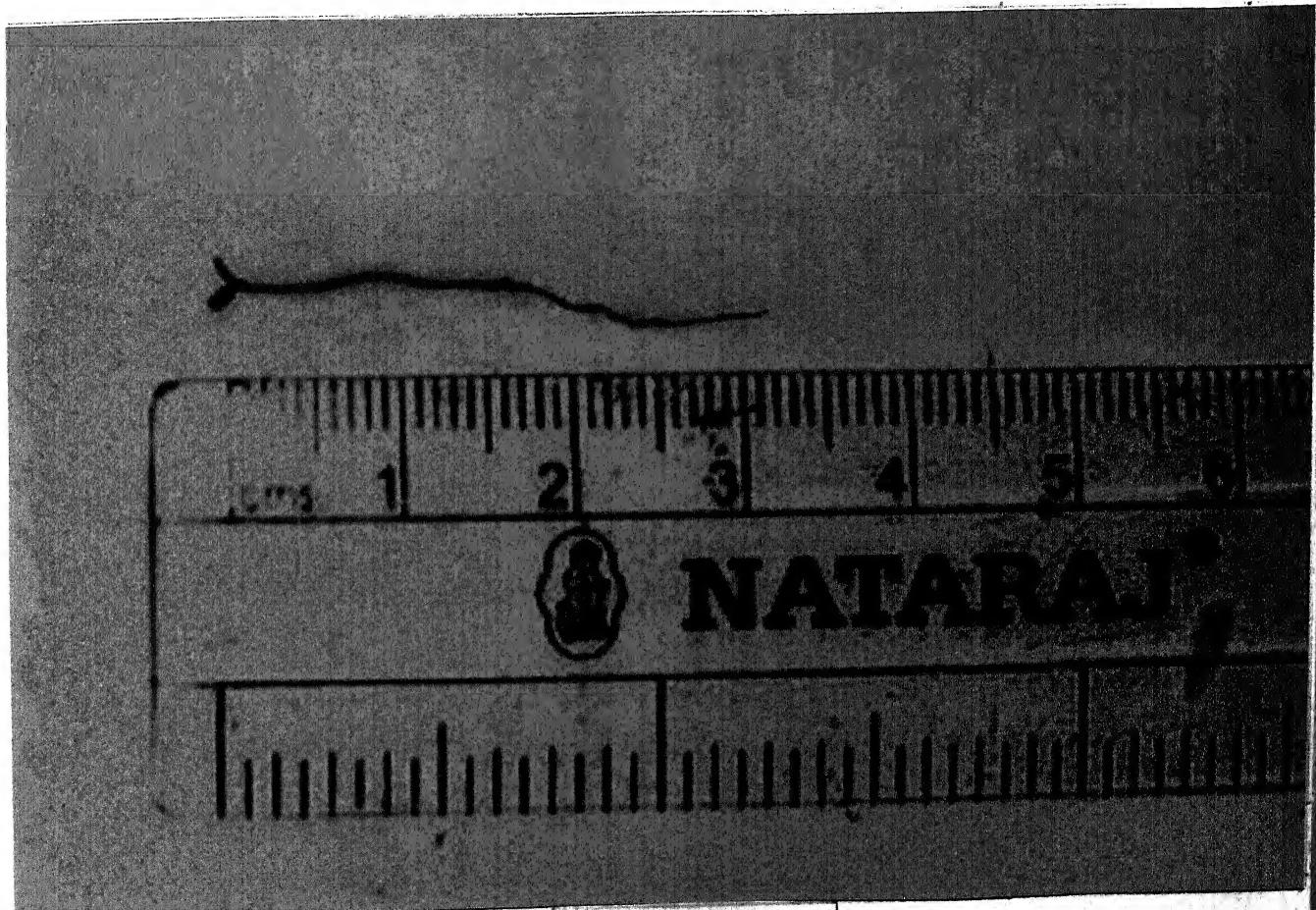


PLATE - XX

Table 6.1 : Effect of storage period on the germination of selected species

Name of Species	Fresh		4 months		8 months		12 months	
	A	B	A	B	A	B	A	B
<i>A. mexicana</i>	91.00	89.00	83.00	80.00	80.00	78.00	79.30	76.30
<i>B. diffusa</i>	95.00	90.00	87.30	84.10	85.30	80.90	83.60	79.10
<i>C. obtusifolia</i>	90.00	85.00	84.00	80.30	83.00	71.30	74.00	70.60
<i>D. metel</i>	93.00	90.00	85.30	80.60	75.60	73.00	72.60	70.30
<i>T. procumbens</i>	85.00	80.00	68.60	60.00	58.40	54.00	52.00	48.00

A = Germination Percentage, B = Plant Percentage

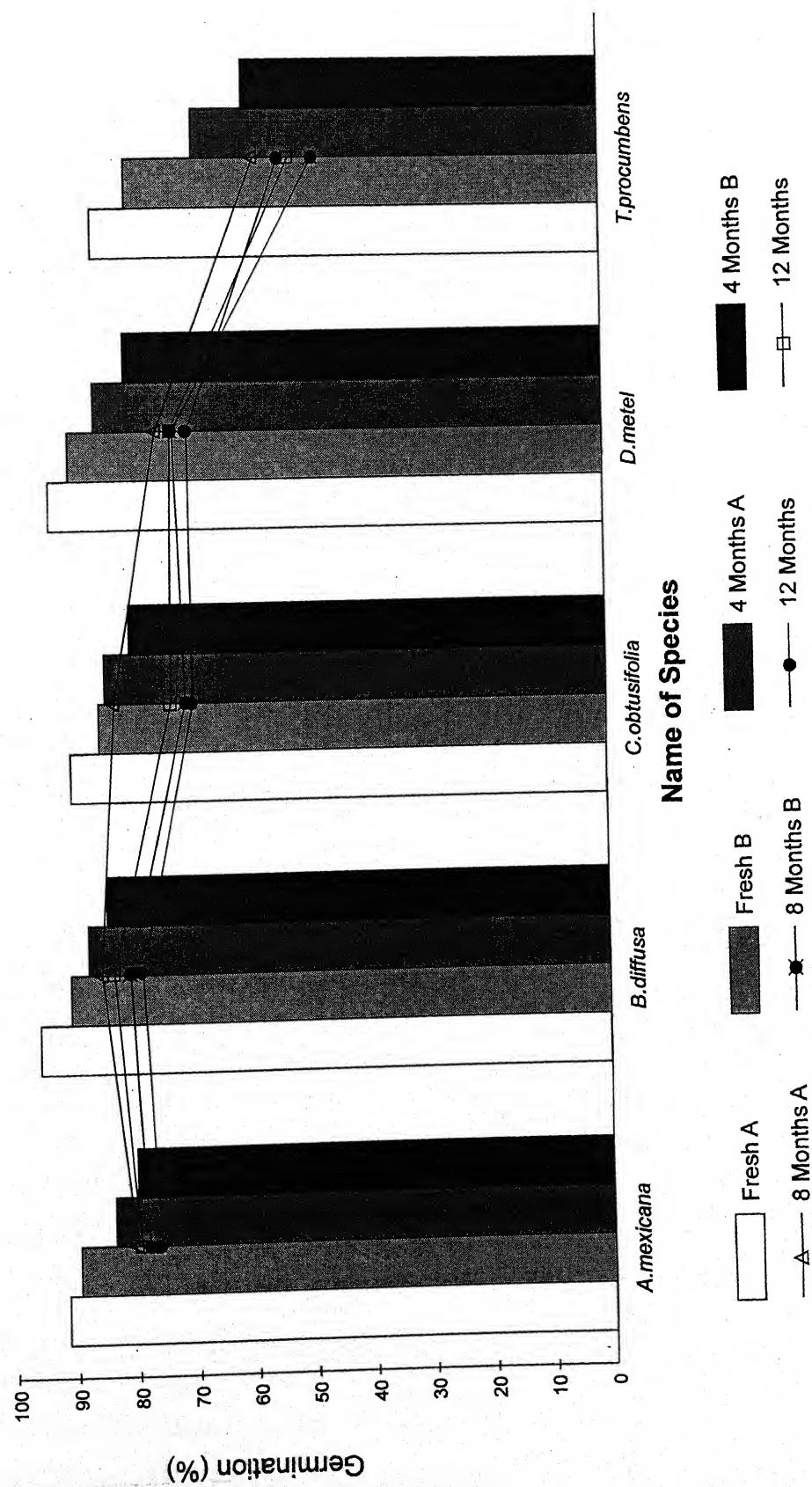


Fig. 7 : Effect of storage period on the germination of selected species

B. diffusa, 93% in *D. metel*, 91% in *A. mexicana*, 90% in *C. obtusifolia* and 85% in *T. procumbens*. In all the five plants a very sharp and distinct decline is seen when it is compared with 4 month old seeds. Further the decline is found to be moderate when 4 months old seeds compared with 6 month old seeds, while the decline was found more or less insignificant when 6 months seeds were compared with 12 months old seeds. In all the five species of medicinal plants *T. procumbens* found to be very sensitive for storage period. It shows a great decline i.e. from 85% (fresh seed) to 52% (12 months stored seed).

Overall in all the cases, it is evident that prolonged storage period decreases the viability of seeds. The gradual loss of germination capacity of seeds during storage can be explained due to degeneration of enzymes, decrease of stored food, gradual coagulation of proteins of the embryos and accumulation of the toxic metabolic products as a result of many catabolic physiological processes.

Sah and Singh (1995) studied *Populus ciliata* seeds for storage effect. The seeds were stored at 20°C in refrigerator and at 10°C in deep freezer. The germination of fresh seed was tested after putting the seeds on moistened filter paper with distilled water. The data indicate that the seed germination at 20°C decreased from 92.0 percent of fresh seeds to 60.5 percent after one year of storage.

Whereas, the seeds stored at 10°C, the germination after one year of storage decreased from 92.0 percent to 30.0 percent. The decrease in seed germination was more pronounced during first three months of storage period.

Bhagat and Singh (1994) summarized storage capacity of some temperate shrubs where the germination percentage is affected by storage period.

Results similar to present observation were described by Agrawal and Sharma (1999). Purohit *et al.* (2000) recorded the response of *Eucalyptus globulus* seed during storage and concluded that the germination of seed between two range of temperature of 30°C and 20°C was 63%, 28% and 7% and 58%, 19% and 3.8% respectively in fresh, one year and two years old seeds.

Imbibition :

Data on the relationship between imbibition and seed germination is interesting and presented in table 6.2 and (fig. 8). Maximum germination percentage was obtained, when the seeds were imbibed for 24 hours in all the five selected species. Similarly plant percent followed more or less the same trend. Speed of germination was also achieved a peak in a imbibition period of 24 hours. When seeds were soaked for more than 24 hours there was a sharp decline in germination percentage and speed of germination.

Table 6.2 : Effect of imbibition hours on seed germination (12 months stored)

Name of Species	Imbibition Hours	Germination Energy (%)	Germination (%)	Plant (%)
<i>A. mexicana</i>	8	41.67	68.00	64.00
	16	42.20	76.00	71.00
	24	44.33	79.00	76.00
<i>B. diffusa</i>	8	14.68	70.00	65.00
	16	29.76	77.00	72.00
	24	32.60	80.00	76.00
<i>C. obtusifolia</i>	8	30.21	62.00	56.00
	16	32.73	64.00	58.00
	24	43.00	67.00	61.00
<i>D. metel</i>	8	41.87	69.00	64.00
	16	42.77	77.00	70.00
	24	45.17	78.00	72.00
<i>T. procumbens</i>	8	25.83	60.00	54.00
	16	39.19	62.00	66.00
	24	59.17	65.00	60.00

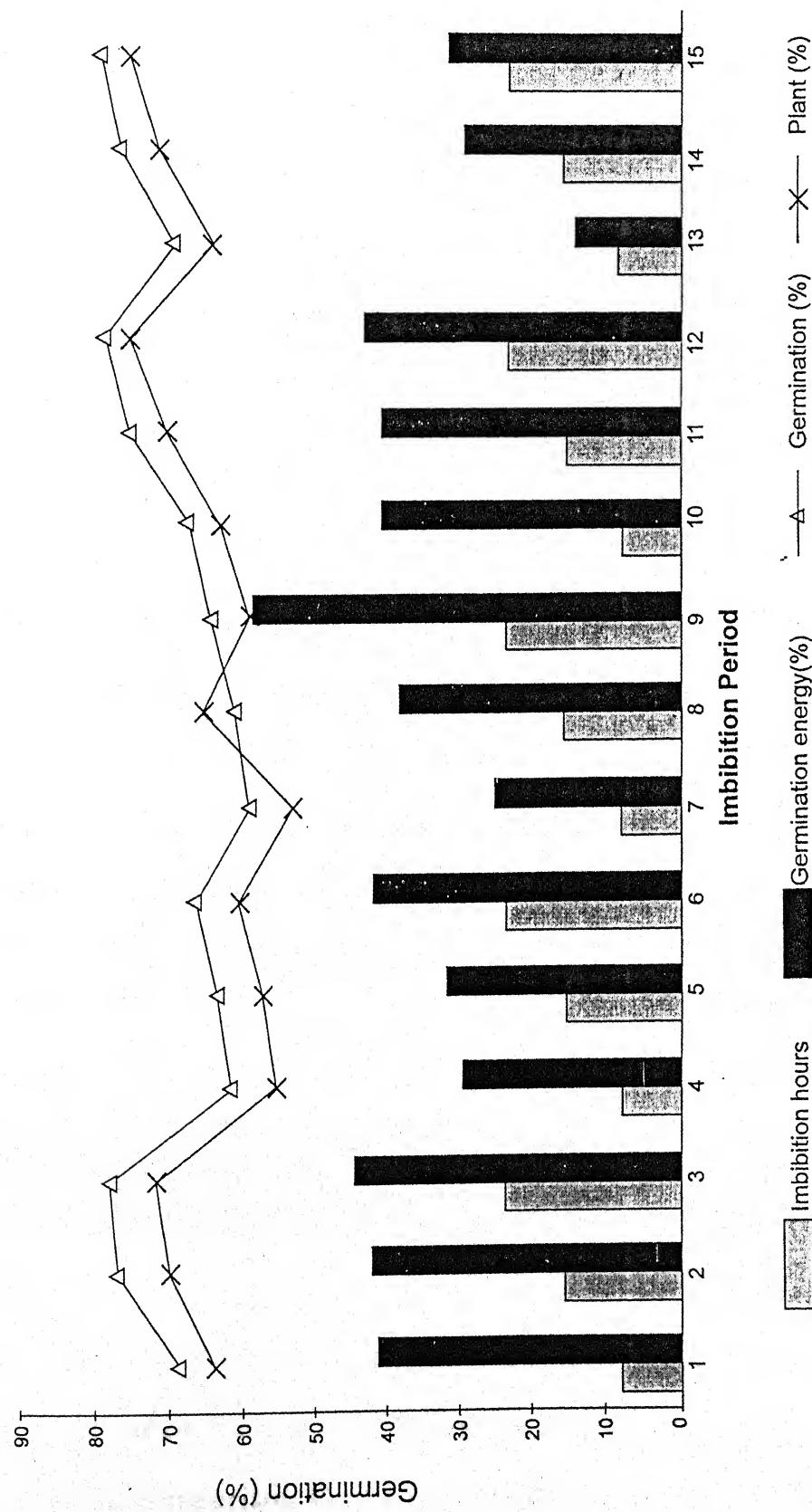


Fig. 8 : Effect of imbibition hours on seed germination

Similar results have been found by Kidd and West (1918, 1919). They found that soaking of seed has a profound effect on the subsequent growth of the plant. Toumey and Durland (1923) studied, soaking effects on a number of coniferous seeds of upland species before sowing and found that soaking for more than 3 to 5 days were generally injurious. Resciher (1941) studied that injurious effect of presoaking of seed of soybean has been attributed to higher water permeability.

Orphan and Heydecher (1968) suggested that soaking injury is caused by deficient oxygen supply to the interior of the soaking seed because during soaking the cavity between the cotyledons is flooded with excess of water. Ghosh *et al.* (1976) found that soaking of seed for 18 hours at room temperature was the best treatment in *Pinus patula*.

Light Condition :

A careful observation of table 6.3, 6.4, 6.5, 6.6, 6.7 and figures 9, 10, 11, 12, 13 indicate the effect of light condition on root length, shoot length and plant length in five medicinal plant species viz., *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. Seeds were germinated in three conditions, full sunlight, semishady and shady light. Plant were exposed for one month. In comparison to other plants the root length of *D. metel* was

Table 6.3 : Effect of light condition on the growth of one month old seedlings of *Argemone mexicana*

Measurement of seedlings	Light Condition					
	Full Sunlight (open)			Semishady (under canopy)		
	Min.	Max.	A.V.± S.E.	Min.	Max.	A.V.± S.E.
No. of Leaves	6.00	11.00	8.5 ± 0.91	7.00	13.00	10.00 ± 1.00
Root Length	4.10	5.00	4.55 ± 0.65	4.30	4.70	4.50 ± 0.65
Shoot Length	6.90	7.00	6.95 ± 0.84	7.20	7.80	7.50 ± 0.87
Plant Length	11.00	12.00	11.5 ± 1.06	11.50	12.50	12.00 ± 1.07

Length in centimeters

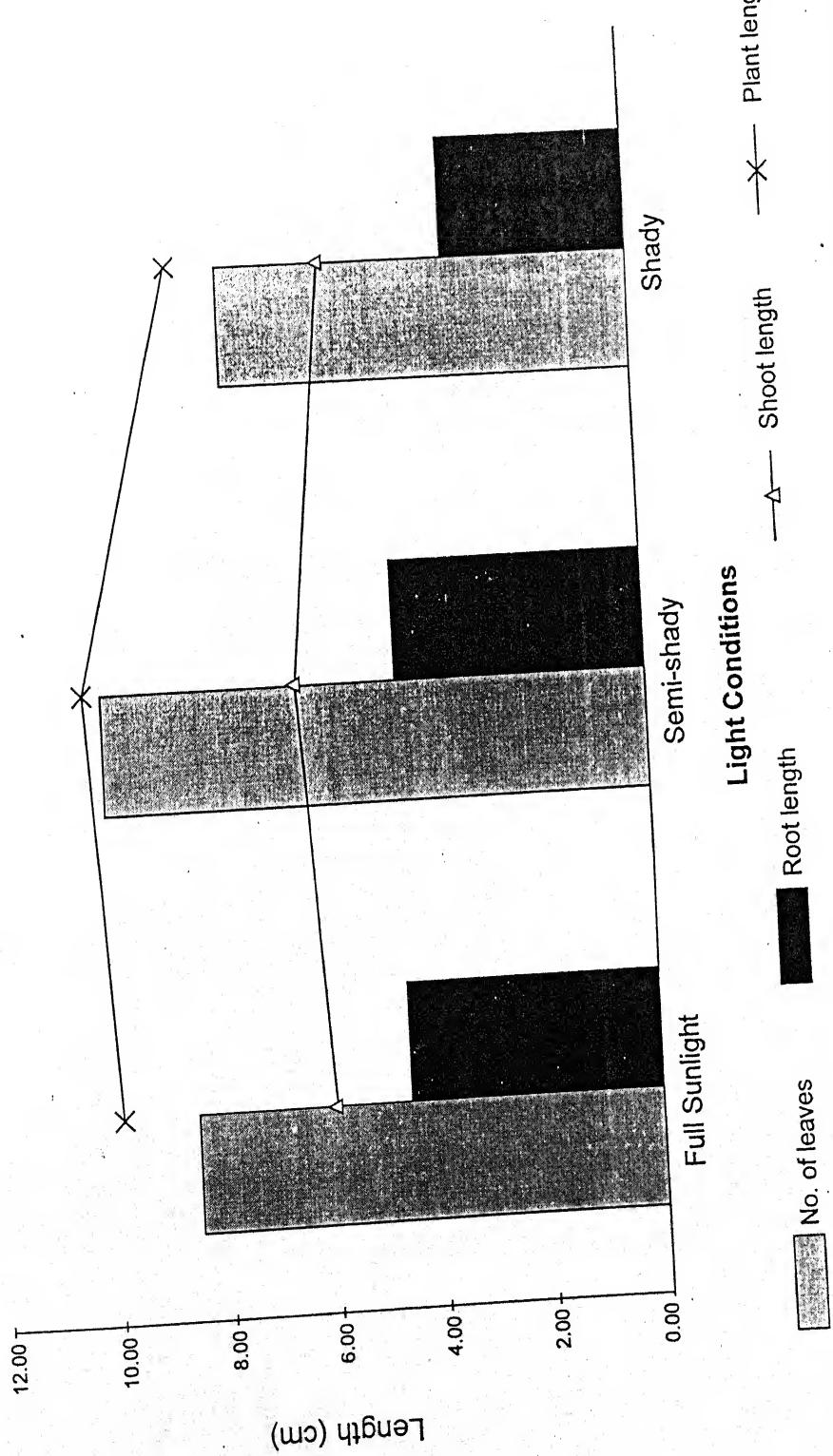


Fig. 9 : Effect of light condition on the growth of one month old seedlings of *Argemone mexicana*

Table 6.4 : Effect of light condition on the growth of one month old seedlings of *Boerhaavia diffusa*

Measurement of seedlings	Light Condition						A.V.± S.E. A.V.± S.E.	A.V.± S.E. A.V.± S.E.	A.V.± S.E. A.V.± S.E.		
	Full Sunlight (open)			Semishady (under canopy)		Shady (diffused light)					
	Min.	Max.	A.V.± S.E.	Min.	Max.	Min.	Max.				
No. of Leaves	8.00	14.00	11.00 ± 1.04	9.00	16.00	12.50 ± 1.09	8.00	13.00	10.5 ± 1.02		
Root Length	2.20	3.10	2.65 ± 0.25	2.70	3.00	2.85 ± 0.45	1.40	1.60	1.5 ± 0.15		
Shoot Length	2.00	2.60	2.3 ± 0.02	2.30	2.70	2.50 ± 0.03	0.90	1.20	1.05 ± 0.05		
Plant Length	4.20	5.70	4.95 ± 0.08	5.00	5.70	5.35 ± 0.09	2.30	2.80	2.55 ± 0.23		

Length in centimeters

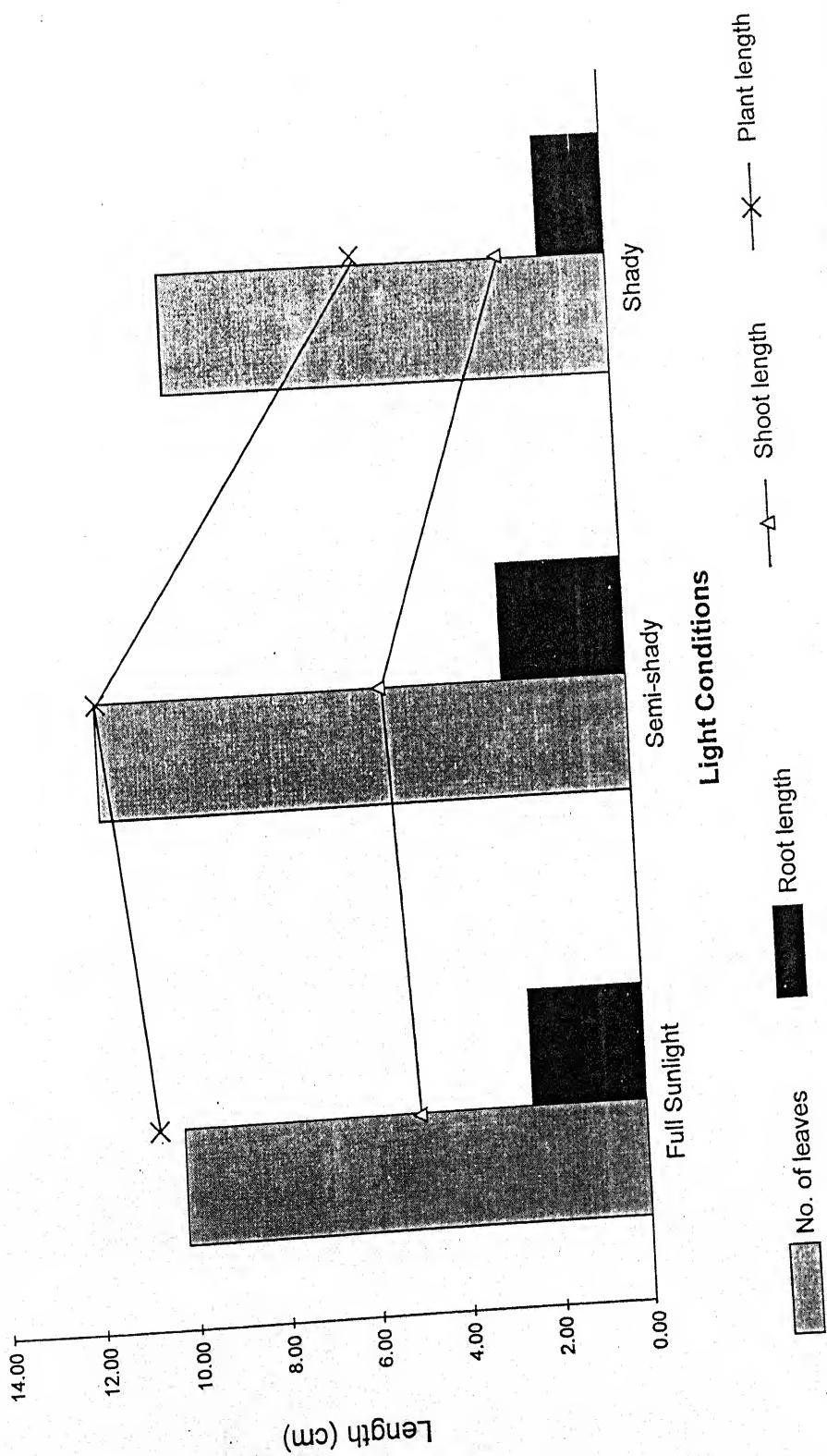


Fig. 10 : Effect of light condition on the growth of one month old seedlings of *Boerhaavia diffusa*

Table 6.5 : Effect of light condition on the growth of one month old seedlings of *Cassia obtusifolia*

Measurement of seedlings	Light Condition					
	Full Sunlight (open)			Semishady (under canopy)		
	Min.	Max.	A.V.± S.E.	Min.	Max.	A.V.± S.E.
No. of Leaves	5.00	10.00	7.5 ± 0.87	7.00	12.00	9.50 ± 0.91
Root Length	2.40	3.00	2.7 ± 0.40	2.60	3.40	3.00 ± 0.24
Shoot Length	9.10	9.30	9.2 ± 0.92	9.70	10.00	9.85 ± 9.11
Plant Length	11.50	12.30	11.9 ± 1.92	12.30	13.40	12.85 ± 1.63

Length in centimeters

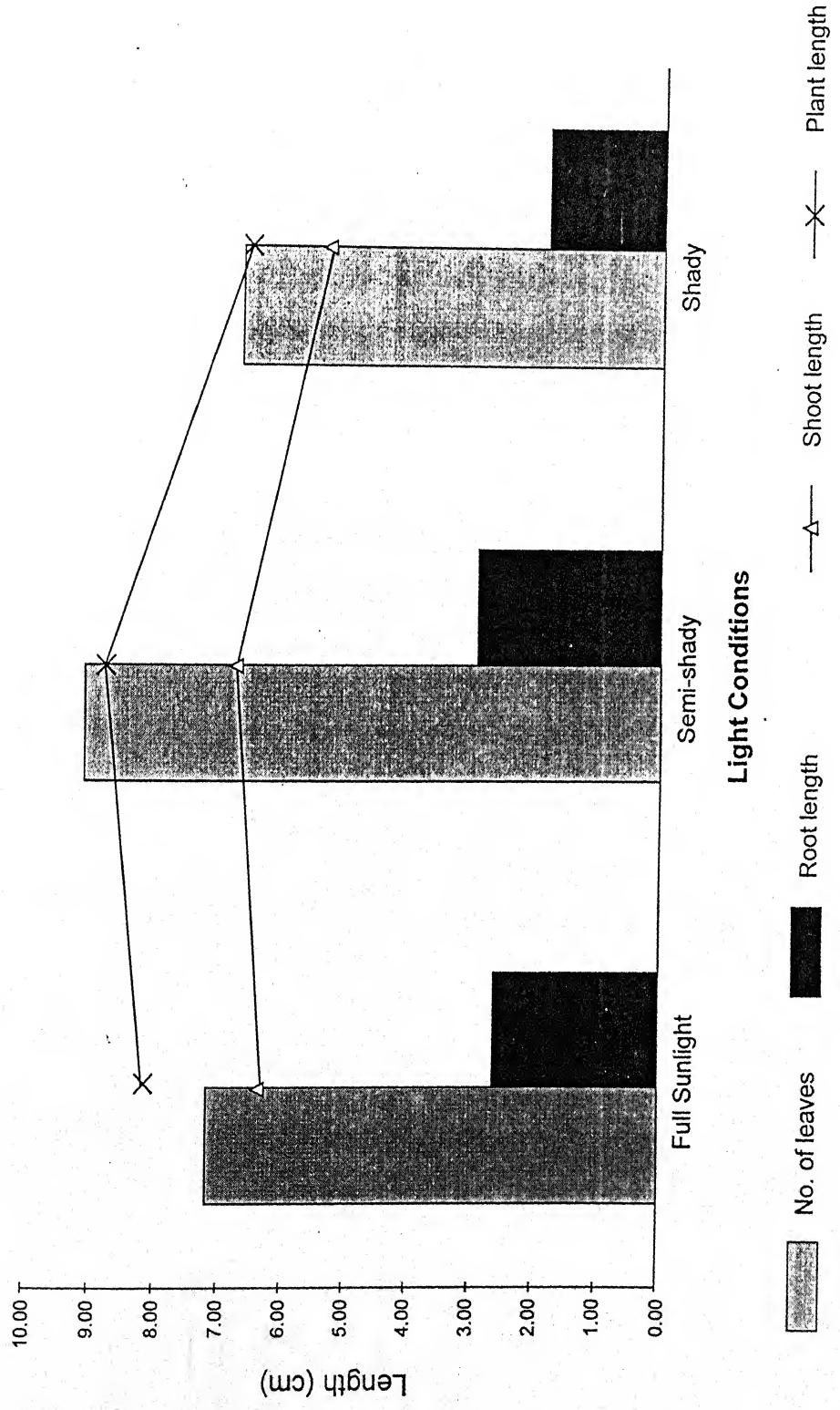


Fig. 11 : Effect of light condition on the growth of one month old seedlings of *Cassia obtusifolia*

Table 6.6 : Effect of light condition on the growth of one month old seedlings of *Datura metel*

Measurement of seedlings	Light Condition					
	Full Sunlight (open)			Semishady (under canopy)		
	Min.	Max.	A.V. \pm S.E.	Min.	A.V. \pm S.E.	Min.
No. of Leaves	7.00	12.00	9.5 \pm 0.97	8.00	14.00	11.00 \pm 1.04
Root Length	8.60	8.80	8.70 \pm 1.04	9.30	9.70	9.50 \pm 0.81
Shoot Length	7.40	7.60	7.50 \pm 0.56	7.10	7.60	7.35 \pm 0.71
Plant Length	16.00	16.40	16.2 \pm 0.01	16.40	17.30	16.85 \pm 0.09

Length in centimeters

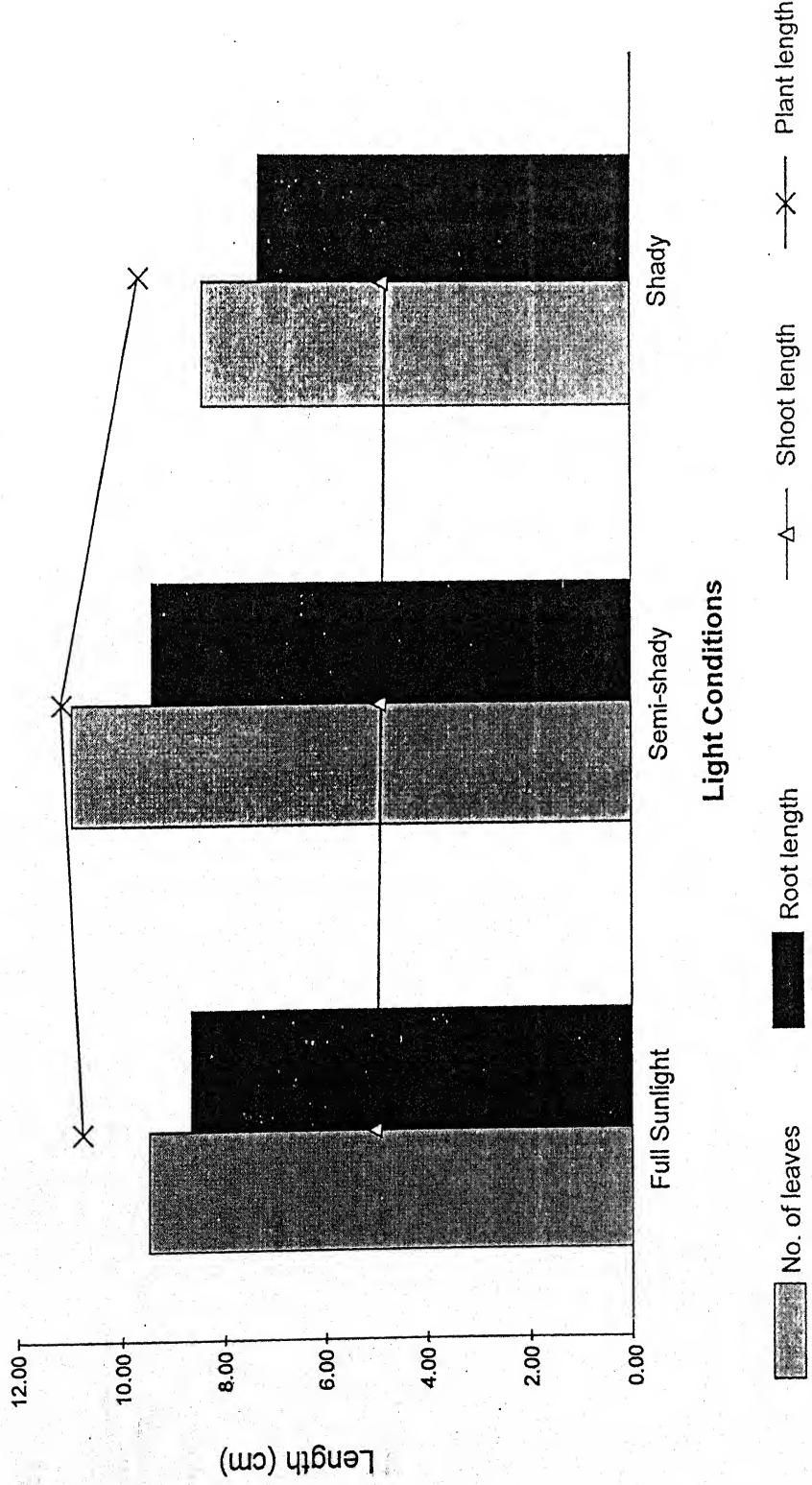


Fig. 12 : Effect of light condition on the growth of one month old seedlings of *Datura metel*

Table 6.7 : Effect of light condition on the growth of one month old seedlings of *Tridax procumbens*

Measurement of seedlings	Light Condition					
	Full Sunlight (open)			Semishady (under canopy)		
	Min.	Max.	A.V.± S.E.	Min.	Max.	A.V.± S.E.
No. of Leaves	5.00	9.00	7.0 ± 0.84	7.00	11.00	9.00 ± 0.95
Root Length	1.60	2.00	1.8 ± 0.25	1.80	2.40	2.10 ± 0.32
Shoot Length	3.00	3.20	3.1 ± 0.49	3.20	3.70	3.45 ± 0.53
Plant Length	4.60	5.20	4.9 ± 0.69	5.00	6.10	5.55 ± 0.74

Length in centimeters



Fig. 13 : Effect of light condition on the growth of one month old seedlings of *Tridax procumbens*

maximum under full sunlight, semishady light and in shady light condition.

No. of leaves were found more in semishady condition in all the plants studied. Although a very significant difference is not seen in semi-shady and full light condition but a sharp change is observed in shady (diffused light) condition.

The influence of light intensity and light quality on the growth of plants is studied by Shirley (1929). Loach (1957) has worked out on the shade tolerance in tree seedlings. Roberts (1971) found that in red oak (*Quercus rubra* L.) the tallest seedlings grew in 30% light. Pathak *et al.* (1983) studied the seedlings raised under 45% light condition showed better height and total dry matter in *Leucaena leucocephala*.

Chaturvedi and Bajpai (1999) studied the effect of different light conditions on germination and seedling growth of some selected forest tree species viz. *Bridelia retusa* (Spreng) H. *antidysenterica* (Wall), *L. parviflora* (Roxb.) and *W. tinctoria* (R. Br.). Seeds were sown in earthen pots filled with a mixture of garden soil, sand and decomposed manure in 2:1:1 ratio. After sowing of seeds, three light conditions viz. semishady, shady and full sunlight were considered for the experiment and observations were made at definite intervals. The above studies showed that root

length was maximum under semishady condition in *B. retusa* and *H. antidyserterica* while in *L. parviflora* and *W. tinctoria* it was maximum in full sunlight. Root/shoot ratio was highest under shady condition in *H. antidyserterica*, *L. parviflora* and *W. tinctoria* respectively. The growth of seedlings of *B. retusa* and *H. antidyserteria* was better in semishady condition and in *L. parviflora* and *W. tinctoria* was higher in full sunlight conditions.

More recently Tiwari, et al. (2000) also studied the effect of different light conditions on seedling growth of some leguminous forest tree species.

Temperature :

Data which are showing the effect of temperature on germination are given in table 6.8, 6.9, 6.10, 6.11, 6. 12 and figure 14, 15, 16, 17, 18.

The percentage of germination was studied from 20°C to 35°C in five species of medicinal plants viz., *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. In all above plants a general trend is observed that in each case percentage of germination is very high in temperature range of 25 - 30°C. It is also evident that germination is very fast i.e. it takes few days to start the germination. The highest percentage is observed in *B. diffusa* which is 73% in the range of 25 - 30°C, followed by *A. mexicana*

Table 6.8 : Effect of temperature on seed germination of *Argemone mexicana*

Temperature (°C)	Beginning of Germination (in days)	Completion of Germination (in days)	Germination (%)	Plant (%)
20°C	6	5	51.82	45.23
	4	8	73.20	68.93
30°C	3	9	71.43	65.50
	3	10	60.82	56.02
35°C				

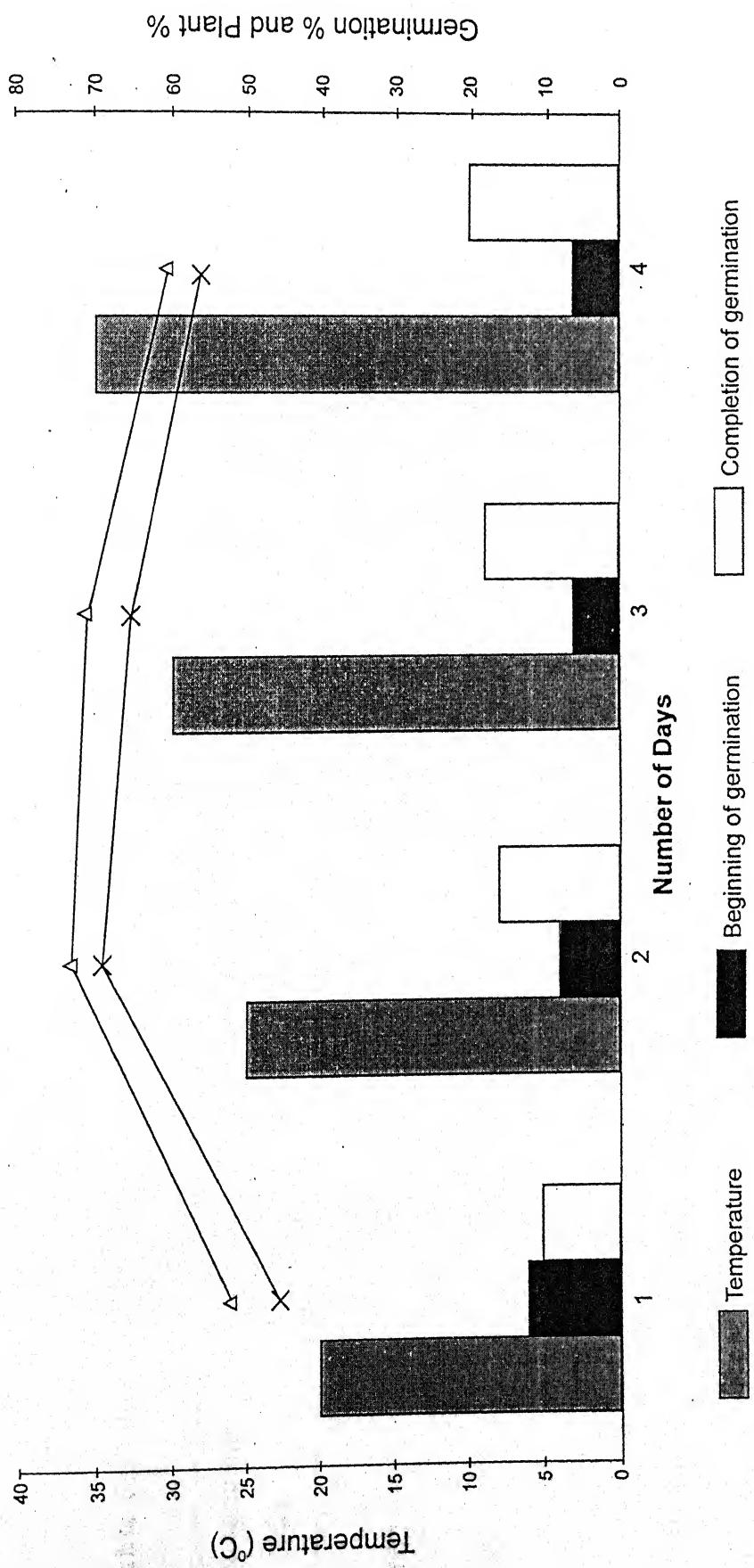


Fig. 14 : Effect of temperature on seed germination of *Argemone mexicana*

Table 6.9 : Effect of temperature on seed germination of *Boerhaavia diffusa*

Temperature (°C)	Beginning of Germination (in days)	Completion of Germination (in days)	Germination (%)	Plant (%)
20°C	5	9	54.77	50.19
25°C	5	8	76.52	73.02
30°C	6	9	74.00	70.83
35°C	7	9	66.29	60.22

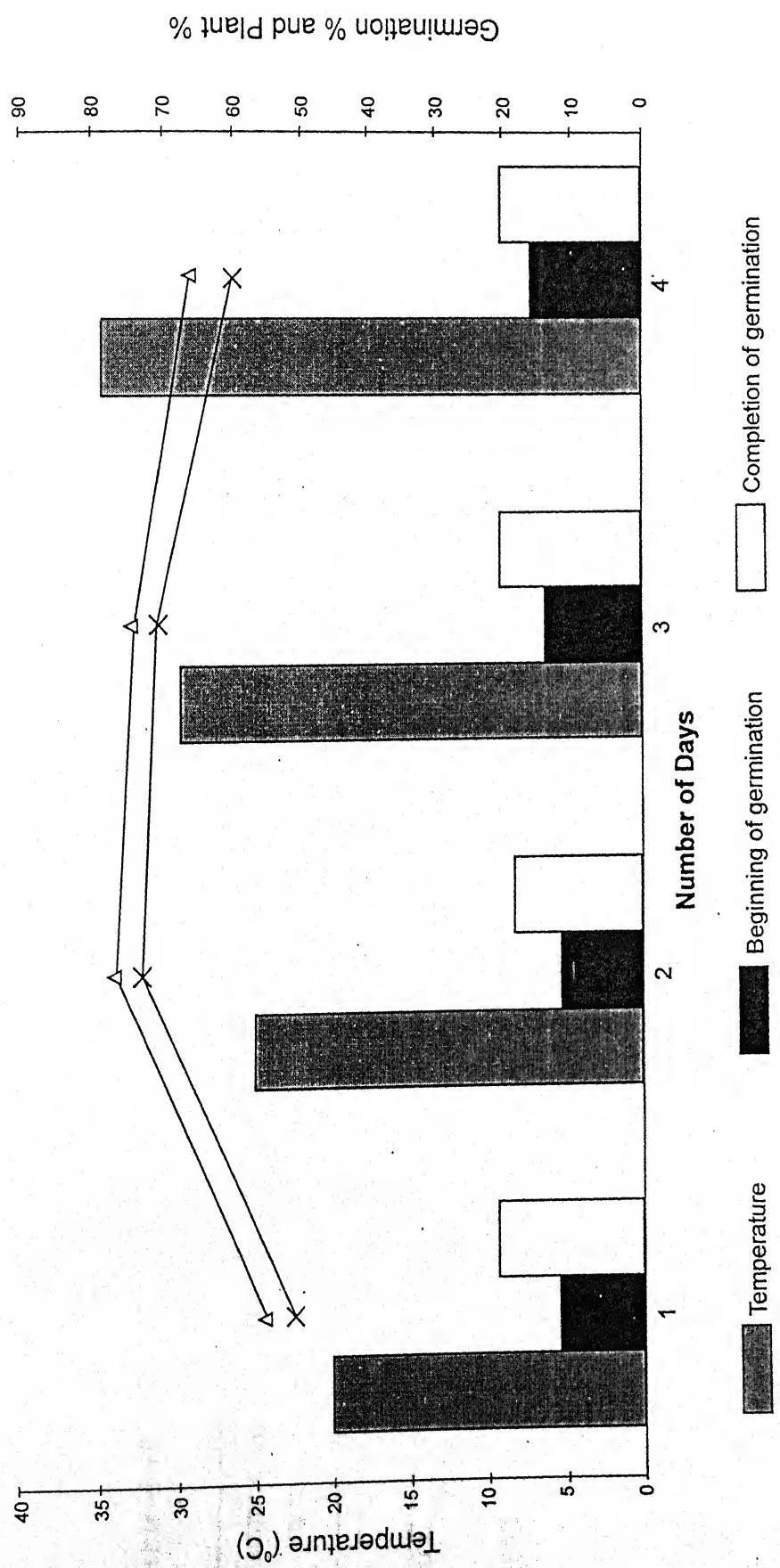


Fig. 15 : Effect of temperature on seed germination of *Boehavia diffusa*

Table 6.10 : Effect of temperature on seed germination of *Cassia obtusifolia*

Temperature (°C)	Beginning of Germination (in days)	Completion of Germination (in days)	Germination (%)	Plant (%)
20°C	5	7	42.66	36.70
25°C	4	6	59.29	54.62
30°C	5	9	54.78	47.00
35°C	4	8	48.92	45.21

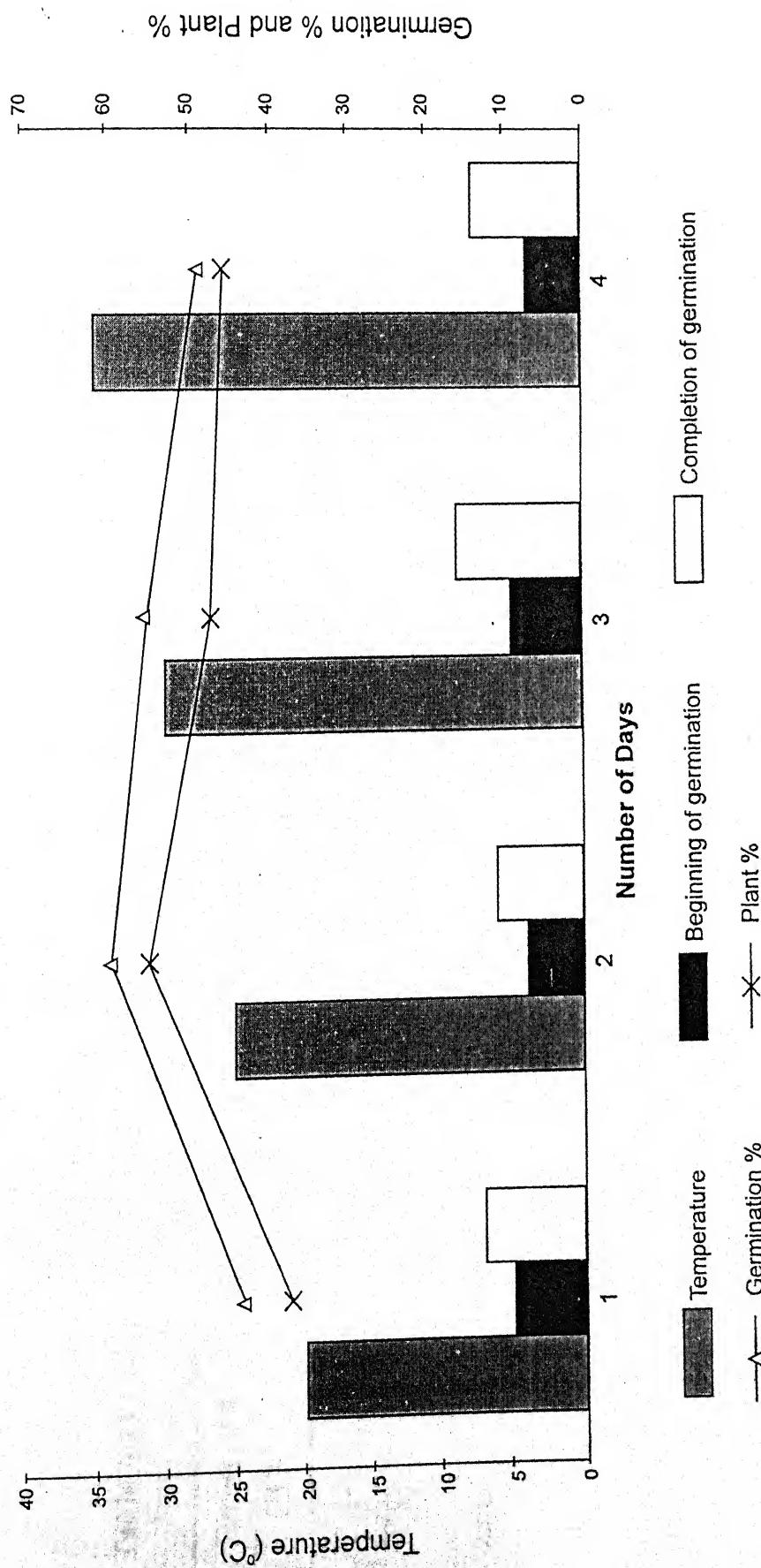


Fig. 16 : Effect of temperature on seed germination of *Cassia obtusifolia*

Table 6.11 : Effect of temperature on seed germination of *Datura metel*

Temperature (°C)	Beginning of Germination (in days)	Completion of Germination (in days)	Germination (%)	Plant (%)
20°C	5	8	45.24	40.70
	3	6	65.20	60.23
30°C	4	7	60.14	55.33
	5	9	49.37	45.82

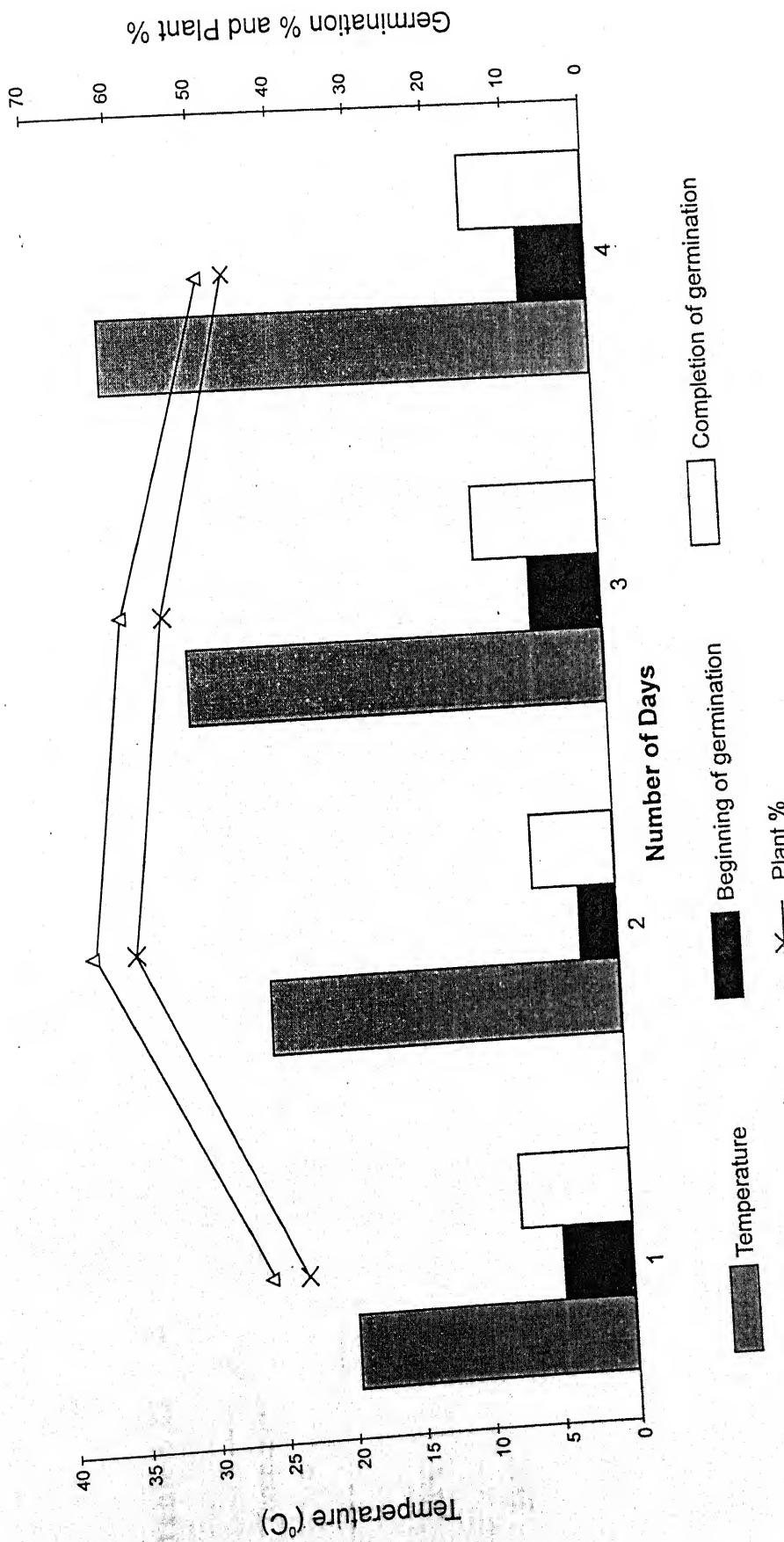


Fig. 17 : Effect of temperature on seed germination of *Datura metel*

Table 6.12 : Effect of temperature on seed germination of *Tridax procumbens*

Temperature (°C)	Beginning of Germination (in days)	Completion of Germination (in days)	Germination (%)	Plant (%)
20°C	5	5	42.87	37.00
25°C	3	4	53.72	58.08
30°C	4	5	48.99	52.17
35°C	5	6	40.32	45.44

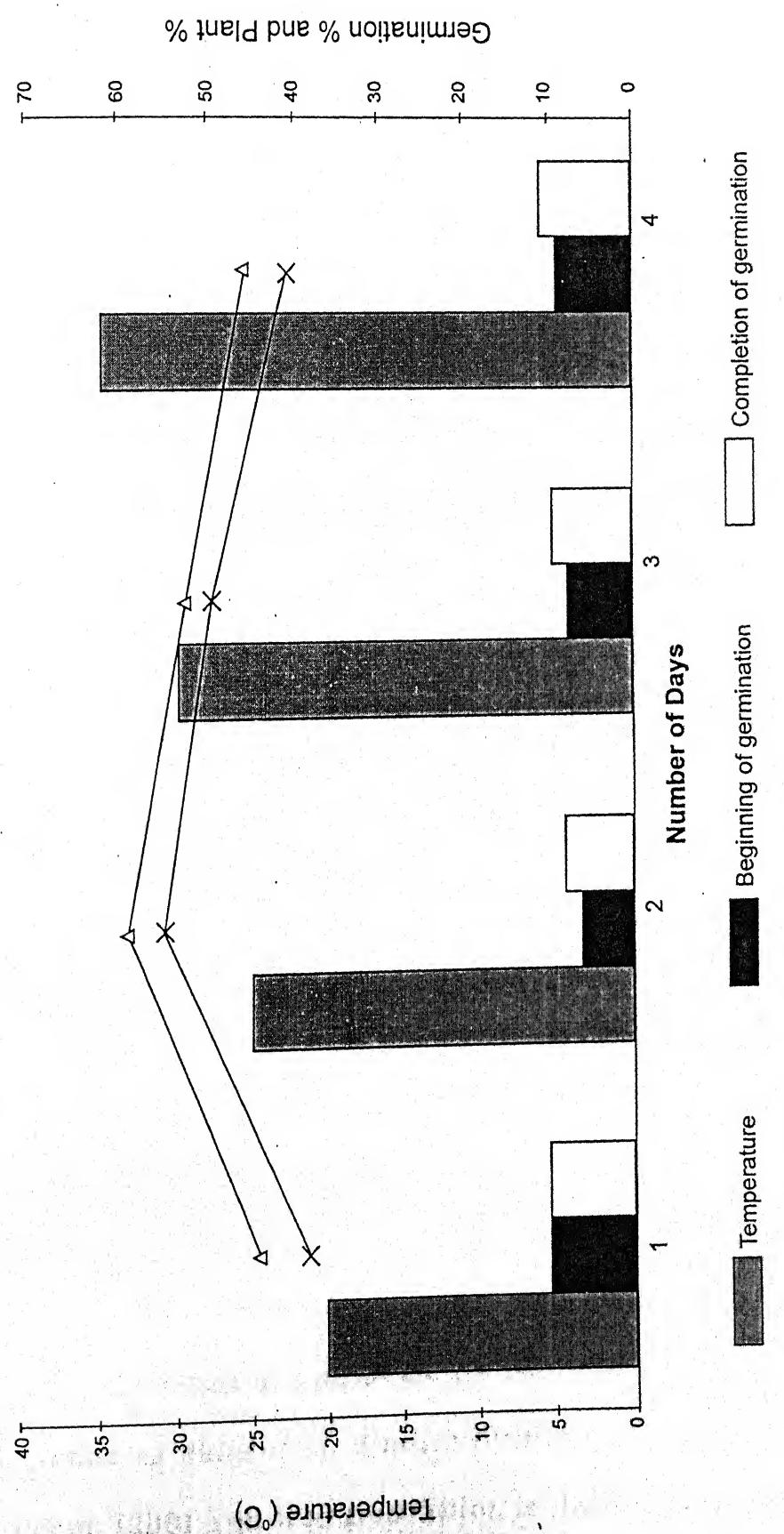


Fig. 18 : Effect of temperature on seed germination of *Tridax procumbens*

(68%), *D.metel* (60%), *C.obtusifolia* (54%) and *T.procumbens* (53%). On moving from 20 to 25°C a very high increase in germination percentage is observed while a slight decline is also observed from 25°C to 30°C range which is not very significant. It can be summed up that seeds in these five species show less germination percentage below 20°C and above 35°C. On the basis of the present study it can be inferred that a temperature range of 20° to 35° was most congenial for germination. The imbibition of water at lower or higher temperature may be due to inhibition of metabolic activities at the extremes of temperature.

The optimum temperature for germination of seed of these species was found to be between 25 to 30°C. No seed could germinate below 20°C and above 35°C.

The results of these studies on temperature relation to seed germination are very much similar to the study by Tiwari (1994), Chaudhary (1994), Tripathi (1995) and Jain (1996). Chaturvedi (1998) also studied the temperature effect on selected forest tree species of tropical dry deciduous forest of Central India and found similar results. Anju *et al.* (2000) studied the effect of different temperature and substrate on the germination of Kadam (*Anthocephalus chinensis*). Similar results have been found by Nikhil *et al.* (2001) on seed germination in *Azadirachta indica* seed.

Potting Media :

Effect of potting media on seed germination of these five species of medicinal plant has been recorded in table 6.13 and figure 19. It is clear from table that the best germination percentage can be observed in S_2 medium in which 50% soil and 50% sand is used. In *Boerhaavia diffusa* germination started after only 4 days and germination percentage is found to be 85 percent. This plant germinates equally good in S_1 and S_3 medium with a slight decline when compared with germination in S_2 medium. In all the five medicinal plant species germination percentage follow the trend $S_2 > S_1 > S_3$. Soil or potting media is one of the most important environmental factors, which play an important role in germination and seedling establishment. The above results confirm the view that sand mixed media is important and most suitable for the growth of seedlings of many plant species at early stage of life. The poor growth in 100% pure soil may be due to excess water holding capacity and cementing effect of the clay particle which does not allow the seedling to come out very easily. Further the poor germination in S_1 medium may be due to its cementing influence which might have caused water logged condition. Similar results have been found by Sabale *et al.* (1995) who discussed the effect of different potting media on germination and seedling growth of clove. Imtiaz (1999) showed the effect of different soils on

Table 6.13 : Germination and plant percentage of seeds in different potting media

Name of Species	Growth Parameter	Potting Media		
		Soil 100% Pure (S ₁) (in %)	50% Soil + 50% Sand (S ₂) (in %)	50% Soil + 50% Saw dust (S ₃) (in %)
<i>A. mexicana</i>	(a)	55	60	54
	(b)	45	52	46
	(c)	11	9	10
<i>B. diffusa</i>	(a)	78	85	79
	(b)	70	77	71
	(c)	5	4	5
<i>C. obtusifolia</i>	(a)	41	50	45
	(b)	30	42	36
	(c)	6	4	5
<i>D. metel</i>	(a)	52	60	54
	(b)	42	51	41
	(c)	11	8	9
<i>T. procumbens</i>	(a)	39	48	43
	(b)	30	40	31
	(c)	7	4	6

(a) = Germination percentage

(b) = Plant Percentage

(c) = Germination started after days.

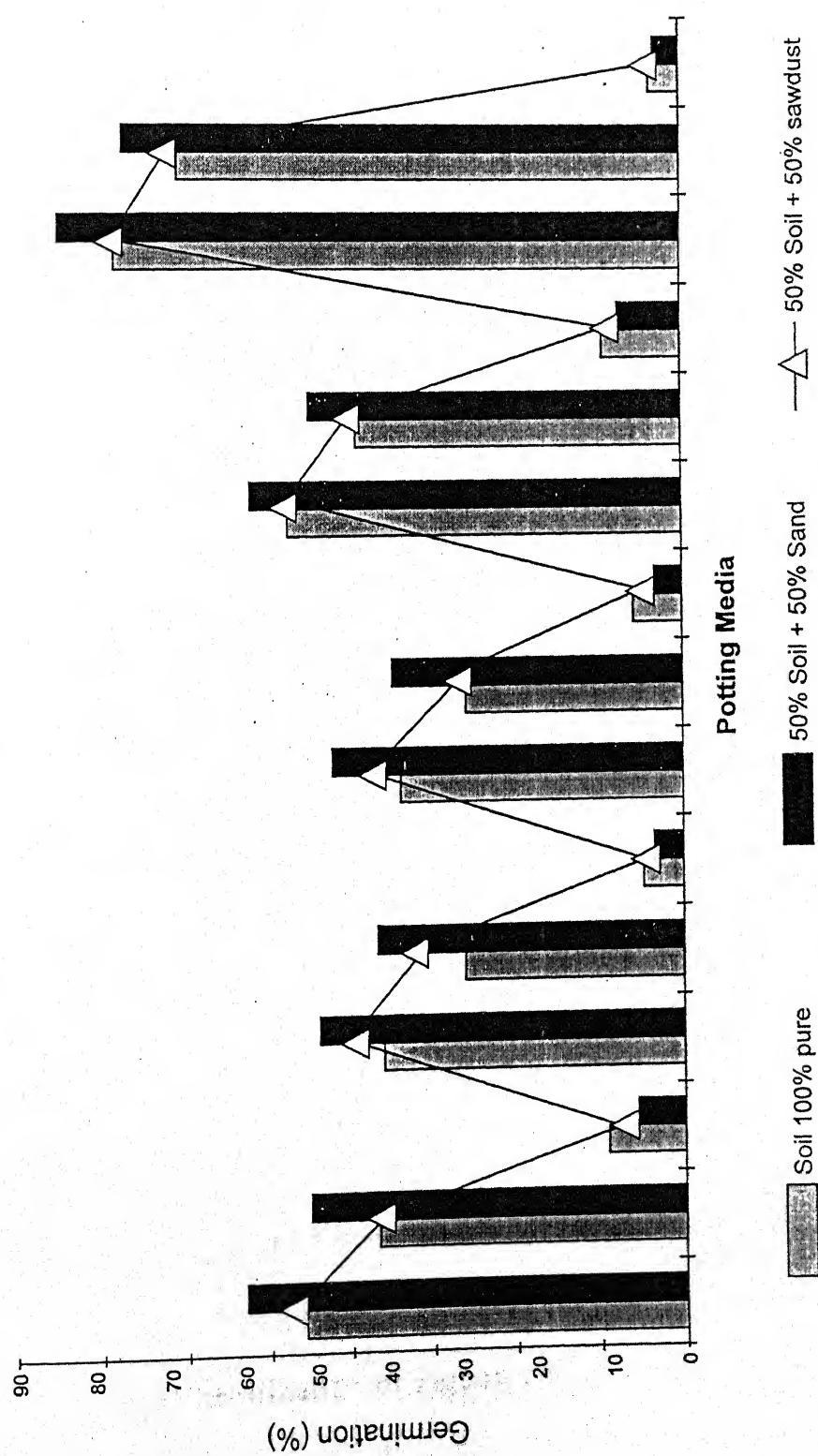


Fig. 19 : Germination and plant percentage of seeds in different potting media

germination, propagation, growth and moisture content of *Mentha longifolia*. More recently Tiwari *et al.* (2001) recorded the effect of different potting media and concluded that the best growth media was soil and sand (S_2) in equal proportion for all selected species. Better result in S_2 was due to good aeration and low moisture content.

Indol Acetic Acid (IAA) :

The effect of different concentration of IAA on seed germination and plant percentage are shown in table 6.14 and fig.20. The data indicates that there was higher germination at the concentration of 1 and 2 ppm in all the test species.

Similar effect at lower concentration of IAA reported by Chaturvedi (1998). Baines (1980) and Mehrotra have described the effect of growth regulators on wheat. Singh *et al.* (1987) have studied the effect of growth regulator and urea on the number of pods of Pigeon pea.

Similar effects of IAA have been described by Rajput (1992). Tiwari (1994) and Jain (1996) have studied the effect of growth regulators on seed germination of Pigeon pea (*Cajanus cajan*).

Table 6.14 : Effect of different concentration of IAA on the germination percentage and plant percentage of different medicinal plant species

Name of Species	Growth Parameter	Concentration (ppm)				
		Control	1	2	5	10
<i>A. mexicana</i>	Germination %	69.00	73.00	75.00	73.00	70.00
	Plant %	67.00	72.00	72.60	72.10	67.90
<i>B. diffusa</i>	Germination %	80.00	82.20	83.60	81.00	73.20
	Plant %	72.00	81.00	82.80	80.20	77.00
<i>C. obtusifolia</i>	Germination %	60.00	64.20	66.10	66.00	65.20
	Plant %	57.00	58.10	64.30	64.00	63.70
<i>D. metel</i>	Germination %	70.00	72.30	74.50	74.00	70.60
	Plant %	67.60	70.00	71.90	71.20	66.90
<i>T. procumbens</i>	Germination %	58.00	61.10	64.00	63.00	60.20
	Plant %	55.00	57.20	60.00	61.60	59.10

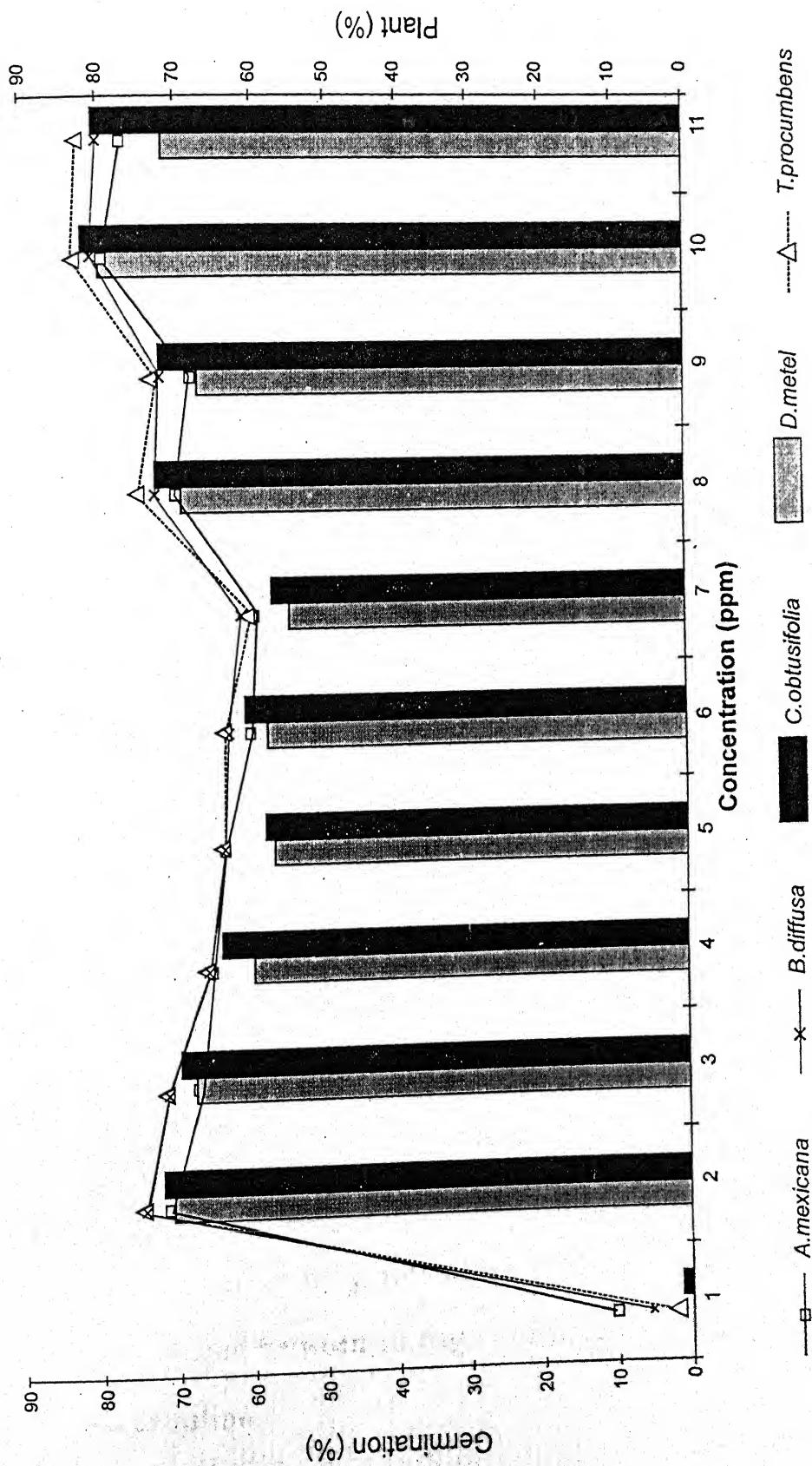


Fig. 20 : Effect of different concentration of IAA on the germination and plant percentage of different medicinal plant species

Indol-3 Butyric Acid and Gibberellic Acid (IBA and GA₃) :

Effect of different concentration of IBA and GA₃ are presented in tables 6.15 and 6.16 and figures 21 and 22 respectively. The data revealed that seed germination was not affected significantly in all the test species.

Effect of application of GA₃ on germination percentage have been studied by so many workers (Baines, 1930; Singh *et al.*, 1987; Dubey, 1991; Jain, 1996 and Chaturvedi, 1998). Maximum germination over the control was observed from 250 ppm (77.7%), thereafter a decrease was observed with significantly higher than control in some Bamboo seeds (Singh and Nayyar, 2000).

Chaturvedi (1998) has worked out on some selected forest tree species. The effect of growth regulator on seed germination and growth performance of *Bridelia retusa* seed were studied by Chaturvedi and Bajpai (1999). More recently Masoodi and Masoodi (2000) described the growth behaviour and germination in *Ulmus wallichiana* seeds. The result obtained by Masoodi revealed that 100 ppm conc. of GA₃ was significantly effective over other treatment in increasing germination by 30%. The mean time of emergence ranged between 35 day in control to 30 days in 200 ppm GA₃ concentration.

Table 6.15 : Effect of different concentration of IBA on the germination percentage and plant percentage of different medicinal plant species

Name of Species	Growth Parameter	Concentration (ppm)				
		Control	1	2	5	10
<i>A. mexicana</i>	Germination %	73.10	75.00	77.10	75.90	71.90
	Plant %	70.00	72.30	75.00	71.60	70.40
<i>B. diffusa</i>	Germination %	84.00	87.00	89.60	85.00	84.00
	Plant %	81.90	85.10	88.00	82.10	83.00
<i>C. obtusifolia</i>	Germination %	66.00	67.00	67.30	66.60	67.00
	Plant %	64.10	66.00	66.70	64.00	65.40
<i>D. metel</i>	Germination %	72.00	73.00	73.10	74.20	72.30
	Plant %	70.10	70.30	70.90	72.00	70.00
<i>T. procumbens</i>	Germination %	64.90	66.00	67.60	65.20	63.00
	Plant %	62.00	63.70	65.00	63.10	61.60

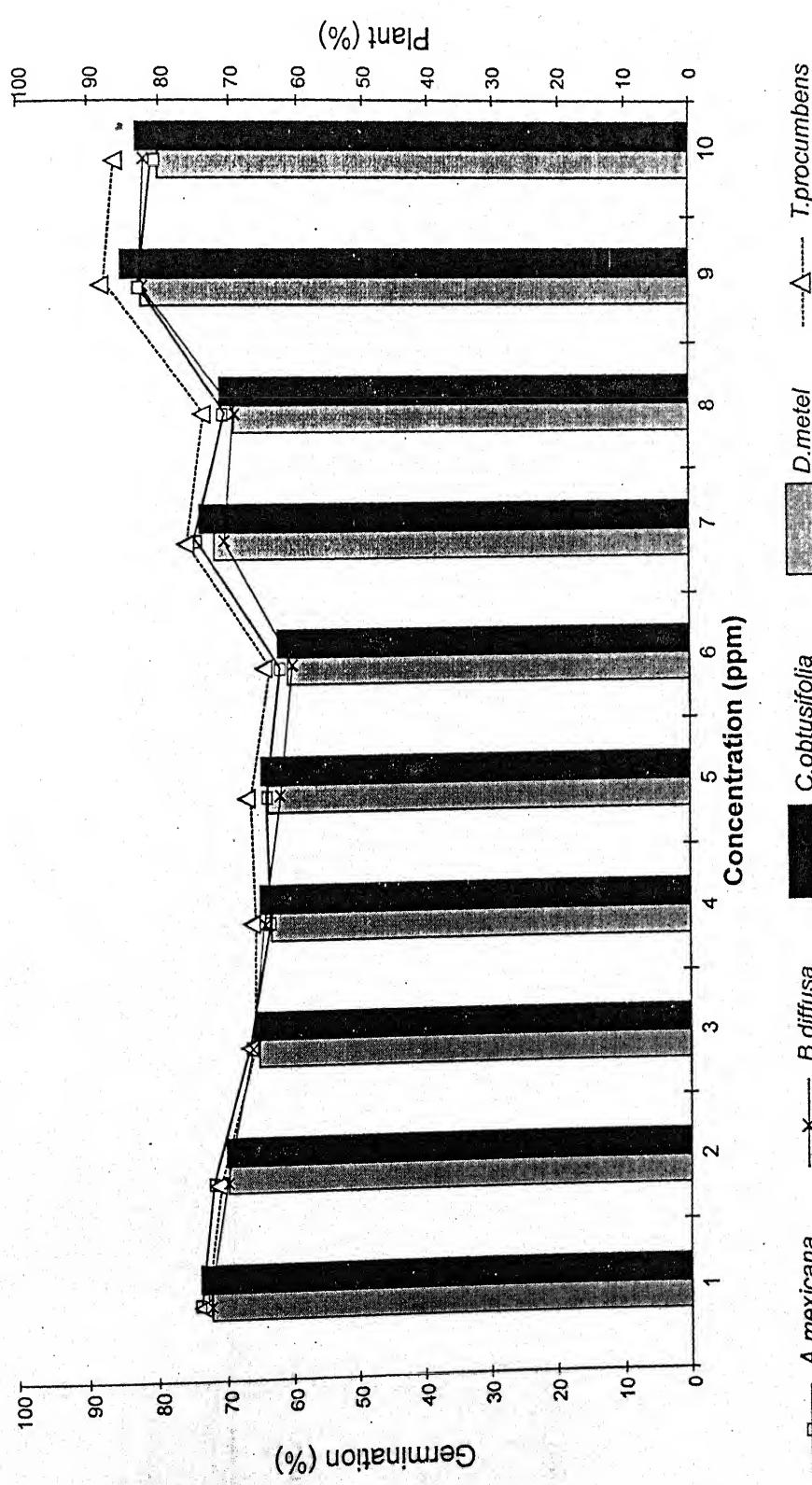


Fig. 21 : Effect of different concentration of IBA on the germination and plant percentageof different medicinal plant species

Table 6.16 : Effect of different concentration of GA₃ on the germination percentage and plant percentage of different medicinal plant species

Name of Species	Growth Parameter	Concentration (ppm)			
		Control	1	2	5
		10			
<i>A. mexicana</i>	Germination %	82.90	83.81	85.10	84.10
	Plant %	81.20	81.90	83.70	83.90
<i>B. diffusa</i>	Germination %	85.00	84.90	86.00	85.00
	Plant %	84.10	84.00	84.00	83.00
<i>C. obtusifolia</i>	Germination %	70.10	72.20	72.30	73.30
	Plant %	68.20	70.30	70.20	72.50
<i>D. metel</i>	Germination %	83.10	82.80	83.80	85.10
	Plant %	81.90	81.10	81.90	84.20
<i>T. procumbens</i>	Germination %	66.10	69.30	69.90	71.20
	Plant %	65.00	68.00	68.30	70.40

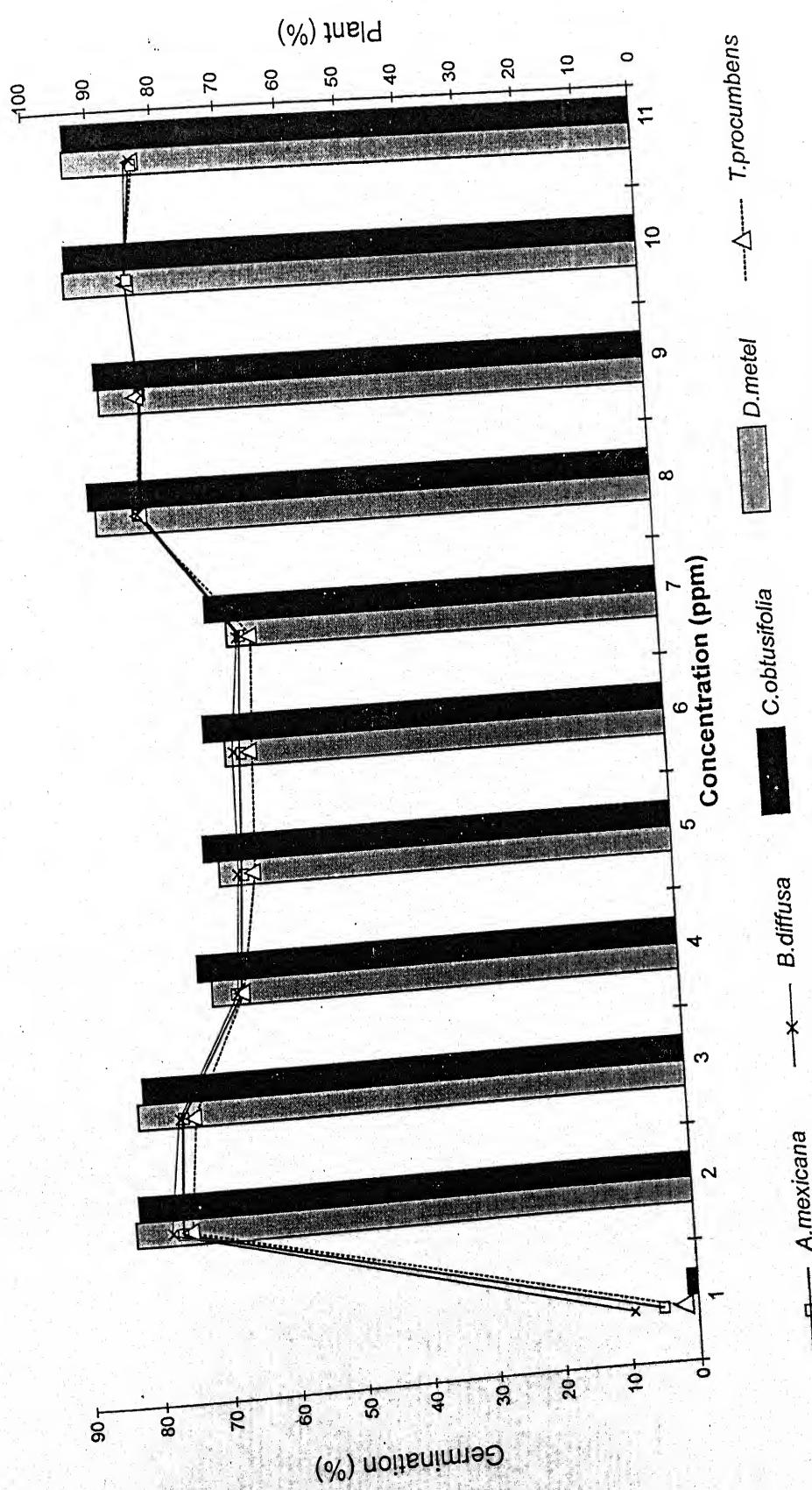
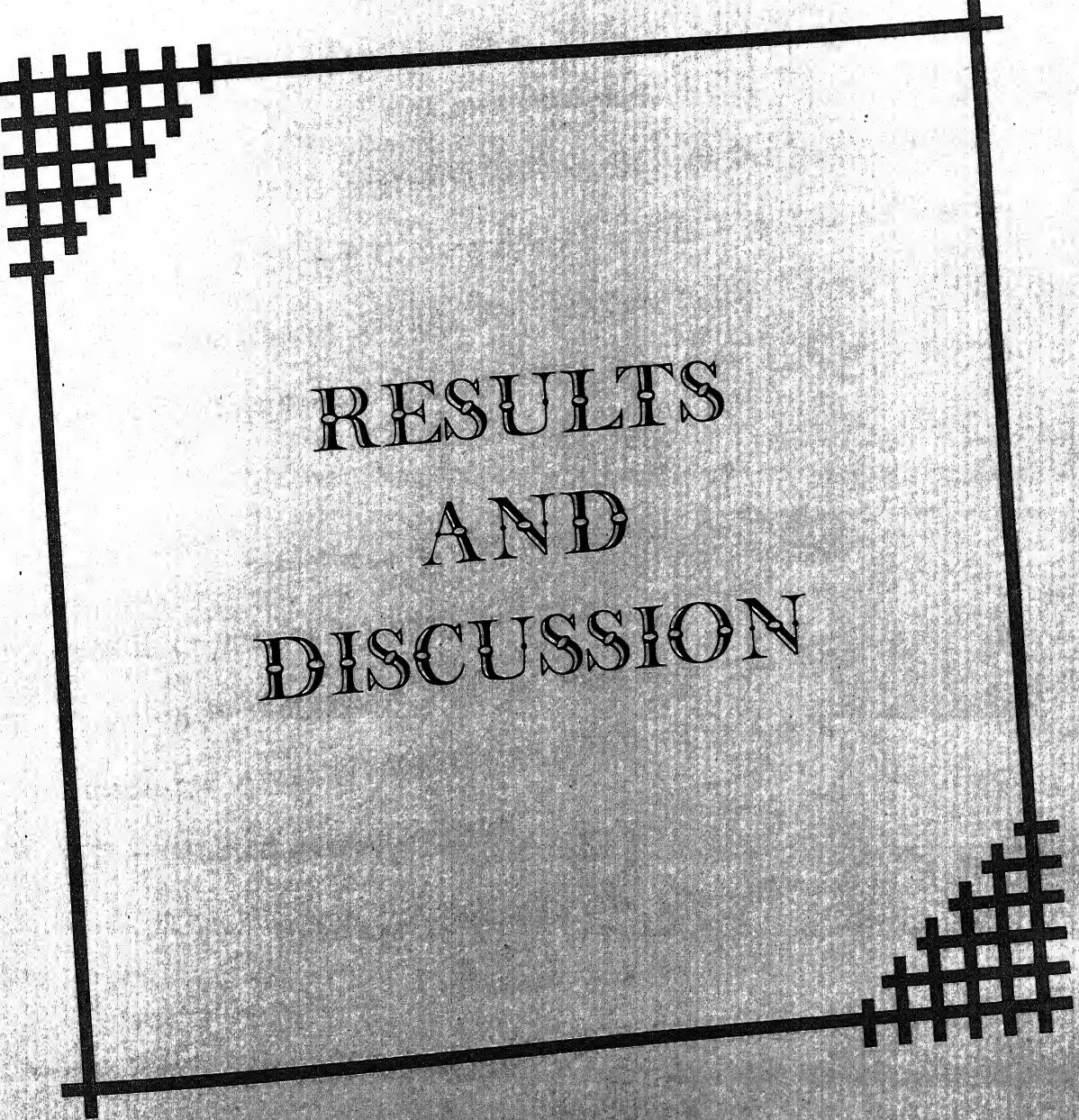


Fig. 22 : Effect of different concentration of GA₃ on the germination and plant percentage of different medicinal plant species



**RESULTS
AND
DISCUSSION**

RESULTS AND DISCUSSION

There are many plants, which have potential medicinal value. India is blessed with medicinal plant diversity as it is clear from the available literature. The earliest of the literature was studied dated 2838-B.C. from *Ebers papyrus*. A number of Indian treaties like Charak Samhita, Navanitakem, Indian medicinal plants by Kirtikar and Basu and other literature were also used in this work.

Sometimes, ethnobotanical study of a single medicinal genus or species is undertaken by surveying various literatures in relation to therapeutic uses and other uses, and examples of such work are Arora (1965), Bisset (1974), Shah and Kapoor (1974).

They studied *Acorus calamus*.

Since every second green plant in India is medicinal plant, this number corresponds to more than 1/4th of the world known medicinal plants which are around 30,000 species. In the present work ethnomedicinal study was done by periodical and ethnomedicinal survey of rural knowledge of Jalaun division from the year 2004-2005.

A total of 5 plant species of ethnobotanical medicinal importance have been included in present study.

All plant species were collected, identified, processed and preserved in herbarium.

The plant species have been used by villagers and are available in study area. It has been revealed that all 5 plants of ethnomedicinal importance belonging to different habits were included in present study. In the present study, families which are ethnomedicinally important are Asteracea, Caesalpiniaceae, Nyctaginaceae, Papaveraceae and Solanaceae.

Some of the common diseases are described in present work, viz. Asthma, Bronchitis, Constipation, Cough and Cold, Cuts and Wounds, Diarrhoea, Dysentery, Eye diseases, Fever, Impotency, Bone fracture, Blood purification, Malarial fever and other such several ailments.

The present study has revealed some interesting plants which cure various types of human ailments. The local medicinemen of Jalaun division use locally available medicinal plant species. The studied plants are used to cure wide ranges of disease, the plants are *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens*.

After surveying the area it was observed that the aged persons in the village area have some knowledge about herbal medicine, certain plant species are used for number of diseases and

their mode of application is variable. These plants are used singly or in combination with other species, they are sometimes used with other natural products, like honey, milk, metals and oxides of heavy metals in different system of medicine like Ayurveda, Unani, Sidha, Homeopathy and Home remedies.

The phenological changes of plants in relation to various phases of their life cycle and seasons are governed by a number of composite factors. In the past few decades a number of workers have studied the factors which have a direct influence on the phenological behaviour of plants. Most of these studies were conducted on agricultural and other cultivated plants. Due to changes in the climatic condition, there is wide fluctuation in the phenology of a species from region to region. Krishnaswamy and Mathuda (1954) have divided the factors influencing phenology into two viz. internal and external ones. Internal factors control the development of the species and in determining the pattern of its phenological behaviour, while external factors modify the influence of internal factors and account for fluctuation. External factors include humidity (Holtum, 1931), precipitation (Champion, 1932), temperature (Leven, 1951 and Ahlgren, 1957), soil moisture, light intensity and its duration (Wareing, 1951 and Njoku, 1963), weather (Lindsey and Newan, 1956) and conditions of microclimate (Jackson, 1966).

Observations on five medicinal plant species viz. *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens* were made during the course of these studies. The data on different phenological events of five medicinal plant species recorded for year 2004-2005 are presented in Fig. 4-5.

Of the five medicinal plants observed 2 species *A. mexicana* and *D. metel* have vegetative growth during the month October to December, whereas *C. obtusifolia* shows such activities between June to August and *B. diffusa* and *T. procumbens* show the vegetative growth almost throughout the year.

Most of the plants enter into the reproductive phase after rainy season. *C. obtusifolia* shows flowering during August to September, whereas *A. mexicana* and *D. metel* December to March. The flowering phase of *B. diffusa* and *T. procumbens* is during September to February.

The ripening of the fruit in *A. mexicana* is April to May, in *C. obtusifolia*, October to November and in *B. diffusa* & *T. procumbens* fruiting time in November to December. In *D. metel* fruit ripening is in February to March.

The result of viability and cutting test are presented in Table 5.1. These results are usually much closer in the case of fresh seeds (Tomey and Stevens, 1928). Seeber and Agapoa (1976) found

correlation between cutting test and germination test in relatively large seed species.

Results of vital staining test are given in table 5.2. Two vital stains Indigo-Carmine and Tetrazolium Chloride have been tried on the seeds, of selected medicinal plant species viz. *A.mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. It is interesting to note that indigo-carmine stains only dead tissue of the embryo and other parts of the seed while tetrazolium stained only living tissue of the seed.

On the basis of tetrazolium chloride staining pattern, seeds have been classified into different classes.

Stained seed including both cotyledon and embryo were classified in class I. Similarly 8 categories were made in all the selected plant species. Percentage of seed belonging to a particular category were compared with the seed germination and actual germination in laboratory. It was noted that staining is comparable with tetrazolium staining up to 4 categories only (Table 5.3, 5.4, 5.5, 5.6, 5.7).

Indigo-Carmine staining (table 5.8, 5.9, 5.10, 5.11, 5.12) were also interpreted on the basis of seed staining patterns. In this case seed with little or no staining were placed in most viable categories and other staining classes were made on the basis of

increase in percentage staining of the seed. Viable staining categories with the laboratory and field germination were compared and found to be significant classes of higher (I to IV) categories. On the basis of present observation, data shows that in all seeds viability can be tested and these were found reliable when compared with laboratory germination. When viable staining category I compared, the Tetrazolium and Indigo-carmine test, results indicated that both tests are useful. However occasionally higher viability estimation may result with T.Z. (Simak and Kamara, 1963).

During present investigation all the selected plant species showed higher viability. Similar variations were observed when the seed viability was evaluated by indigo-carmine staining. The results are comparable with actual germination due to penetration of stain in seed (Flemion and Poole, 1948, Vincent 1957). Relative penetration of stain depends on the membrane integrity of seed and enzyme concentration. On the basis of present investigation, it can be concluded that I.C. is superior over T.Z. staining as it is less time consuming. The stain is not damaged due to light and has good solubility and can be stored for long duration of time. The seeds were evaluated after a storage of 12 months at room temperature.

Seed viability determined by tetrazolium chloride test by various workers showed good relationship with viability and

germination (Mukherji, 1956; Unalcin, 1979; Kandy and Babeley, 1984; and Moore, 1985). Buszewicz and Holmes (1957) considered embryo with about 1/6 of the unstained area as viable. This appears to be correct in many cases, but the area at which necrosis occurs in embryo also seems to be of significance. In view of the above findings the results of the present study can be interpreted. Lakon (1950) also emphasized the importance of necrosis on the endosperm in the tetrazolium test. Bulat (1957) considered those seeds viable which were having completely stained embryo and endosperm. Further, most of the seeds contained decisive tissue, which has ability to repair small superficial necrosis of limited extent even within, "Decisive tissue", (ISTA, 1983). Neljubov (1925) studied that the indigo carmine stains dead or dying tissue of the embryo readily but leaves the living tissue unstained. From the degree of staining of embryo, the germination capacity of the seed has been estimated during the course of the present investigation. Saha *et al.* (1995) have reported several factors for the short viability period of the seed of *Shorea robusta*. In present investigation, the status of the viability period of the seeds stored for 12 months at room temperature is reported. Similar results have also been obtained Yadav *et al.* (1988) in the seeds of *Chloroxylon swietenia* (Bhirra). They have determined seed viability by tetrazolium and indigo-carmine staining.

The present study mainly concerned with the germination of seeds of medicinal plant particularly in the influence of different environmental conditions so that a ideal set of conditions can be presented for the cultivation practices of medicinal plants. Different factors such as storage period, temperature, potting media, light conditions which influence the germination of seeds are studied.

Germination is the process of conversion of seed into seedling, which involves different sequential series of morphogenetic event. This embryo eventually is converted into seedling. During this whole process different factors affect at one or many steps of the process. Germination starts with imbibition of seeds and ultimately development of seedling.

Storage period of seeds before germination affect the germination percentage of seeds which is shown in table 6.1 for the five selected species i.e. *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. A careful perusal of these tables reveal that the germinability of seeds of all five species exhibits a trend of sharp decline at room temperature with increase in the storage period from fresh seeds to 12 months old seeds. The percent germination was found 95% in *B. diffusa*, 93% in *D. metel*, 91% in *A. mexicana*, 90% in *C. obtusifolia* and 85% in *T. procumbens*. In all

the five plants a very sharp and distinct decline is seen when it is compared with 4 months old seeds. Further the decline is found to be moderate when 4 months old seeds were compared with 6 month old seeds. The decline was found more or less insignificant when 6 months seeds were compared with 12 months old seeds. In all the five species of medicinal plants *D.metel* was found to be very sensitive for storage period. It shows a great decline 85% (fresh seed) to 52% (12 months stored seed).

Overall in all the cases, it is evident that prolonged storage period decreases the viability of seeds. The gradual loss of germination capacity of seeds during storage can be explained due to degeneration of enzymes, decrease of stored food, gradual coagulation of proteins of the embryos and accumulation of the toxic metabolic products as a result of many catabolic physiological processes.

Sah and Singh (1995) studied *Populus ciliata* seeds for storage effect. The seeds were stored at 20°C in refrigerator and at 10°C in deep freezer. The germination of fresh seed was tested after putting the seeds on moistened filter paper with distilled water. The data indicate that the seed germination at 20°C decreased from 92.0 percent of fresh seeds to 60.5 percent after one year of storage. Whereas, the seeds stored at 10°C, the germination after one year of storage decreased from 92.0 percent

to 30.0 percent. The decrease in seed germination was more pronounced during first three months of storage period.

Bhagat and Singh (1994) summarized storage capacity of some temperate shrubs where the germination percentage is affected by storage period.

Results similar to present observation were described by Agrawal and Sharma (1999). Recently Purohit *et al.* (2000) recorded the response of *Eucalyptus globules* seed during storage and concluded that the germination of seed between two range of temperature i.e. 30°C and 20°C was 63%, 28% and 7% and 58%, 19% and 3.8% respectively in fresh, one year and two years old seeds.

Imbibition :

Data on the relationship between imbibition and seed germination is interesting and presented in table 6.2 and fig. 8. Maximum germination percentage was obtained, when the seeds were imbibed for 24 hours in all the five selected species. Similarly plant percent followed more or less the same trend. Speed of germination was also achieved a peak in a imbibition period of 24 hours. When seeds were soaked for more than 24 hours there was a sharp decline in germination percentage and speed of germination.

Similar results have been found by Kidd and West (1918, 1919). They found that soaking of seed has a profound effect on the subsequent growth of the plant. Toumey and Durland (1923) studied soaking effects on a number of coniferous seeds of upland species before sowing and found that soaking for more than 3 to 5 days were generally injurious. Resciher (1941) studied that injurious effect of presoaking of seed of soybean has been attributed to higher water permeability.

Orphan and Heydecher (1968) suggested that soaking injury is caused by deficient oxygen supply to the interior of the soaking seed because during soaking the cavity between the cotyledons is flooded with excess of water. Ghosh *et al.* (1976) studied that soaking of seed for 18 hours at room temperature exhibited as best treatment in *Pinus patula*.

Light Condition :

A careful observation of table 6.3, 6.4, 6.5, 6.6, 6.7 and figures 9, 10, 11, 12, 13 indicate the effect of light condition on root length, shoot length and plant length in five medicinal plant species viz. *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. Seeds were germinated in three conditions, full sunlight, semishady and shady light and plants were exposed for one month. In comparison to other plants the root length of *D. metel* was

maximum under full sunlight, semi-shady light and in shady light condition.

No. of leaves were found more in full sunlight while it is in semi-shady condition in *D. metel*. Although a very significant difference is not seen in semi-shady and full light condition but a sharp change is observed in shady (diffused light) condition.

The influence of light intensity and light quality on the growth of plants is studied by Shirley (1929). Loach (1957) has worked out on the shade tolerance in tree seedlings. Roberts (1971) found that in red oak (*Quercus rubra* Linn) the tallest seedlings grew in 30% light. Pathak *et al.* (1983) studied the seedlings raised under 45% light condition showed better height and total dry matter in *Leucaena leucocephala* Linn.

According to Chaturvedi and Bajpai (1999) the effect of different light conditions on germination and seedling growth of some selected forest tree species viz. *Bridelia retusa* (Spreng.) *H. antidysenterica* (Wall), *L. parviflora* (Roxb.) and *W. tinctoria* (R.Br.). Seeds were sown in earthen pots filled with a mixture of garden soil, sand and decomposed manure in 2:1:1 ratio. After sowing of seeds, three light conditions viz. semi-shady, shady and full sunlight were considered for the experiment and observation were made at definite intervals. The above studies showed that root

length was maximum under semi-shady condition in *B. retusa* and *H. antidyseterica* while in *L. parviflora* and *W. tinctoria* it was maximum in full sunlight. Root/shoot ratio was highest under shady condition in *H. antidyseterica*, *L. parviflora* and *W. tinctoria* respectively. The growth of seedlings of *B. retusa* and *H. antidyseterica* was better in semi shady condition and in *L. parviflora* and *W. tinctoria* was higher in full sunlight condition .

More recently Tiwari *et al.* (2000) also studied the effect of different light conditions on seedling growth of some leguminous forest tree species.

Temperature :

Data which are showing the effect of temperature on germination are given in tables 6.8, 6.9, 6.10, 6.11, 6.12 and figures 14, 15, 16, 17, 18.

The percentage of germination was studied from 20°C to 35°C in five species of medicinal plants viz. *A. mexicana*, *B. diffusa*, *C. obtusifolia*, *D. metel* and *T. procumbens*. In all above plants a general trend is observed that in each case percentage of germination is very high in temperature range of 25°C- 30°C. It is also evident that germination is very fast i.e. it takes few days to start the germination. A highest percentage is observed in *B. diffusa* which is 73% in the range of 25°C, followed by *A. mexicana* (68%),

D.metel (60%), *C.obtusifolia* (54%) and *T.procumbens* (53%). On moving from 20 to 25°C a very high increase in germination percentage is observed while a slight decline is also observed from 25°C to 30°C range which is not very significant. It can be summed up that seeds in these five species show less germination percentage below 20°C and above 35°C. On the basis of the present study it can be inferred that a temperature range of 20 to 35° was most congenial for germination. The imbibition of water at lower or higher temperature may be affected due to inhibition of metabolic activities at the extremes of temperature.

The optimum temperature for germination of seed of these species was found to be between 25 to 30°C. No seed could germinate below 20°C and above 35°C.

The results of these studies on temperature relation to seed germination are very much similar to the study by Tiwari (1994), Chaudhary (1994), Tripathi (1995) and Jain (1996). Chaturvedi (1998) also studied the temperature effect on selected forest tree species of tropical dry deciduous forest of Central India and found similar results. Anju *et al.* (2000) studied the effect of different temperature and substrate on the germination of Kadam (*Anthocephalus chinensis*). Similar results have been found by Nikhil *et al.* (2001) on seed germination in *Azadirachta indica* seed.

Potting Media :

Effect of potting media on seed germination of these five species of medicinal plant has been recorded in table 6.13 and figure 19 . It is shown in table that the best germination percentage can be observed in S_2 medium in which 50% soil and 50% sand is used. In *B. diffusa* germination started after only 4 days and germination percentage is found to be 85 percent. This plant germinates equally good in S_1 and S_3 medium with a slight decline when compared with germination in S_2 medium. In all the five medicinal plant species germination percentage follow the trend as $S_2 > S_1 > S_3$. Soil or potting media is one of the most important environmental factor , which play an important role in germination and seedling establishment. The above results confirm the view that sand mixed media is important and most suitable for the growth of seedlings of many plant species at early stage of life. The poor growth in 100% pure soil may be due to excess water holding capacity and cementing effect of the clay particle which does not allow the seedling to come out very easily. Further the poor germination in S_1 medium may be due to its cementing influence which might have caused water logged condition. Similar results have been found by Sabale *et al.* (1995) who have discussed the effect of different potting media on germination and seedling growth of clove. Imtiaz (1999) showed the effect of different soils on

germination, propagation, growth and moisture content of *Mentha longifolia*. More recently Tiwari *et al.* (2001) recorded the effect of different potting media and concluded that the best growth media was soil and sand (S_2) in equal proportion for all selected species. Better result in S_2 was due to good aeration and proper moisture content.

Indol Acetic Acid (IAA) :

The effect of different concentration of IAA on seed germination and plant percentage are shown in table 6.14 and figure 20. Data indicates that there was higher germination at the concentration of 1 and 2 ppm in all the species.

Similar effect at lower concentration of IAA is reported by Chaturvedi (1998). Baines (1980) and Mehrotra have described the effect of growth regulators on wheat. Singh *et al.* (1987) have studied the effect of growth regulator and urea on the number of pods of Pigeon pea.

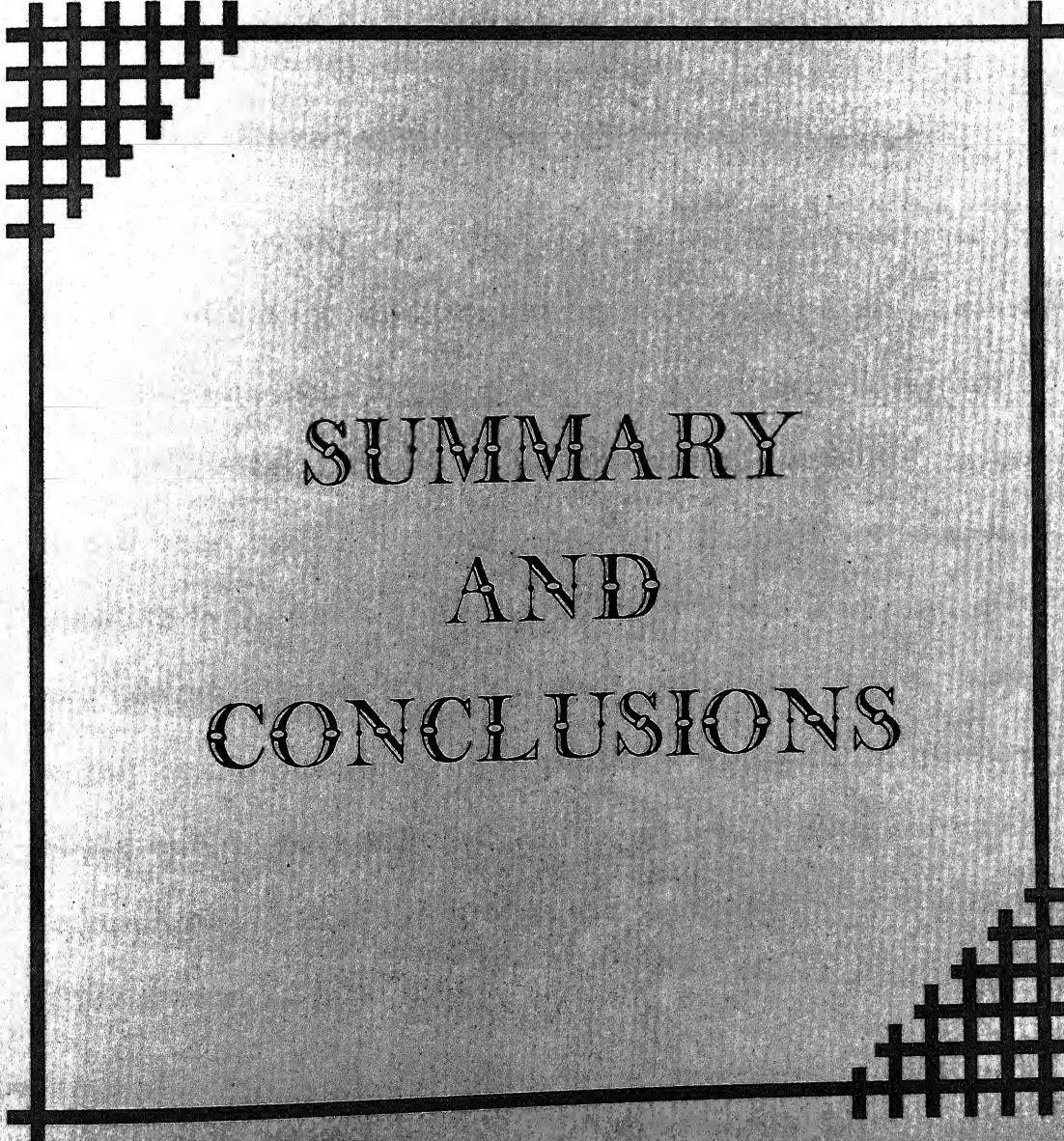
Similar effects of IAA were described by Rajput (1992), Tiwari (1994) and Jain (1996). They have studied the effect of growth regulators on seed germination of Pigeon pea (*Cajanus cajan*).

Indol-3 Butyric Acid and Gibberellic Acid (IBA and GA₃) :

Effect of different concentration of IBA and GA₃ are presented in Table 6.15 and Figure 21. The data revealed that seed germination was not affected significantly in all the test species.

Effect of application of GA₃ on germination percentage have been studied by so many workers (Baines, 1980; Singh *et al.* 1987; Dubey, 1991; Jain, 1996 and Chaturvedi, 1998). Maximum germination over the control was observed from 250 ppm (77.7%), thereafter a decrease was observed with significantly higher than control in some Bamboo seeds (Singh and Nayyar, 2000).

Chaturvedi (1998) has worked out some selected forest tree species. The effect of growth regulator on seed germination and growth performance of *Bridelia retusa* seed was studied by Chaturvedi and Bajpai (1999). More recently Masoodi and Masoodi (2000) described the growth behaviour and germination in *Ulmus wallichiana* seeds. The result obtained by Masoodi revealed that 100 ppm conc. of GA₃ was significantly effective over other treatment in increasing germination by 30%. The mean time of emergence ranged between 35 days in control to 30 days in 200 ppm GA₃ concentration.



**SUMMARY
AND
CONCLUSIONS**

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Ecology deals with the mutual relationships and interactions between organisms and their physical environment.

The physical factors of the atmosphere, the climate and the soil affect the physiological functions of the plant in all its manifestations thus, to a large degree, plant ecology is a phase of plant physiology under natural and uncontrolled conditions; in fact, it has been called "outdoor physiology". Plants are intensely sensitive to the forces of the environment and both their association into communities and their geographical distribution are determined largely by the character of climate and soil. Moreover, the pressures of the environment and of organisms upon each other are potent forces, which lead to new species and the continuing evolution of larger groups.

The relation of man with its surroundings vegetation is age old and the use of plants for his multipurpose need dates back to centuries. Because of sheer necessity man has been using plants and their products for food, clothing, shelter and above all for alleviating diseases.

The term 'Ethnobotany' has been used currently to define the medicinal uses of plants in relation to human beings. In other words we can say that Ethno-medicine is the ethnobotany of medicinal plants. 'Ethnomedicine' is a system of medicine which gives the initial medicinal information about a particular plant.

Advancement of science and medicine have developed an unprecedented pressure on the limited natural resources during the present century.

The term 'Ethnobotany' was first used by Harshburger (1985) and its scope was much elaborated later (Ford, 1978; Foulks 1958). Since then there has been a growing interest in this field (Jain 1986; Martin 1995).

Ethnomedicinal knowledge is very ancient in India. Even recorded ethnobotany of India might well be among the earliest in the world. Though all traditional systems of medicine had their root in ethnobotany, yet organised studies in ethnobotany are very recent. During last 30 years ethnobotany of particular plant groups known to specific tribes of particular regions has aroused interest among researchers to probe the problem with an inter disciplinary approach. There has been a rapid and wide spread interest in recent years in ethnobotanical studies mainly because of the search of

potentially new medicines and their economic viability. So, there is a need for conservation and utilization of plant resources found in tribal areas for socio-economic development. Ethnobotany deals with studies among the tribal and rural people for recording their unique knowledge about plant wealth and for search of new resources of herbal drugs. Modern researches have often borne out the efficacy of many of the crude plant drugs used by aborigines.

On account of their great potentiality for the production of natural indigenous drugs, and because of lack of any previous work on medicinal plants of this region the present attempt was made to study the herbal plants used by the local inhabitants of Jalaun district. Many areas of this region are inhabited by rural people and forest dwellers, who more often use many local plants for the treatments of their ailments. These communities living in remote areas of this region in forest, provide good scope for the study of the folk medicine.

The present thesis entitled "Ethnobotanical and Ecological Studies on Some Medicinal Plant species in Bundelkhand Region (U.P.)" contains an information on native medicinal plants of Jalaun district used by rural people to cure number of diseases. The

observations have been grouped into six chapters followed by result & discussion, summary & conclusion and references.

1. Introduction :

The first chapter deals with the introductory part of the work.

The beginning part of the chapter contains introduction of Ethnobotany and Ecology.

Ethnomedicinal study and their germination and phenological trials are undertaken during the course of study. For this purpose five species viz. *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens* are selected. These were collected from the different sites of Jalaun district.

The study area situated in Bundelkhand region (U.P.) occupies almost the central position in the country. Total geographical area of the district is 494844 ha Jalaun, Orai, Konch, Kalpi, Madhogarh, Ait, Jagammanpur and Nadigaon are major places of the district. Jalaun, the part of Bundelkhand region (U.P.) is characterized with northern tropical dry deciduous scrubby, type of forest. Geologically the area of the region is mainly made up of two types of rocks i.e., Basalt and Vindhyan Sandstone.

2. Ethnobotanical Studies :

The chapter gives detailed methods applied in field collection. Detailed information about the collection and the Proforma for field collection have been obtained from native people. Taxonomical account, description and uses of these plant and plant part is noted by rural people of Jalaun district. Collection of plants was done frequently in different seasons so that different changes in plants can be observed. Herbarium is prepared in each case, since it works as data bank of plant.

Further this chapter deals with the various medicinal properties, vegetative and flowering characteristics on the basis of survey conducted during different seasons of the year.

3. Ecological and Phenological Description of Plant :

In the beginning of the chapter Ecology and Phenology of the plants are studied. In this chapter morphological features and the phenological studies on these five species were made for year 2004-2005. Five species namely *Argemone mexicana*, *Boerhaavia diffusa*, *Cassia obtusifolia*, *Datura metel* and *Tridax procumbens* were observed during the study period. Scientific research has indicated that the timing of phenophases is clearly correlated with air, temperature, soil temperature, photoperiod, soil

moisture but vary from species to species. Therefore, phenological changes in response to climatic change will have a wide range of consequences for ecology, agriculture/forestry and Human health.

Of the five medicinal plants *A.mexicana* and *D.metel* have vegetative growth during the month of October to December. *C.obtusifolia* shows such activity between June to August and *B.diffusa* and *T.procumbens* show vegetative growth throughout the year.

All the five medicinal plant species enter in the reproductive phase after rainy season.

The fruit ripening takes place during April to May in *A.mexicana*, November and December in *B. diffusa* and *T.procumbens* while it is in between February to March in *D.metel* and October to November in *C.obtusifolia*. Phenological phases are presented in the form of symbols.

4. Seed Collection and Seed Characteristics :

In this chapter different characteristics of seeds and seed collection have been discussed. Seed plays an important role in propagating the species thus its characteristics become important as far as germination of seed is concerned.

Seeds were collected in different stages of maturation, i.e.

- (i) When seeds fully formed and mature but did not dehisce, by hand plucking.
- (ii) Next collection was made when seeds were just to dehisce, by slight hand jerk.

During seed collection it is essential to have clear knowledge of ripening period of seed, time of maturity.

In all the five species of medicinal plants morphological features like seed weight, seed size etc. have been observed. Later collection of seeds usually decreases the viability of seeds. Large sized seeds are more viable because large sized seeds have much amount of endosperm hence higher nutritive value, which leads to viable seeds.

5. Study of Seed Viability :

Seed viability is the capacity of seeds to germinate for some specific period of time. Viability of seeds for longer periods ensure regeneration even when favourable situation is available after long interval.

Depending on visual examination or the application of physical and chemical characters of seed, the viability can be examined.

The results of cutting test have provided significantly accurate picture of healthy seeds correlated with germination percentage. The data on vital staining of seeds and germination percentage indicate that viability can be tested using tetrazolium and indigocarmine staining tests and these were found to be reliable when compared with laboratory germination. Field germination can be provided in all the species with this method. On the basis of these staining a number of vigour classes were made.

In response to tetrazolium stain *D.metel* shows maximum viability and in *A.mexicana* it is slightly less, followed by *C.obtusifolia*. *T.procumbens* shows least viability.

While staining with indigo carmine stain *D.metel* shows maximum viability followed by *A.mexicana* which also show good viability. Similarly, *C.obtusifolia* also has a good degree of viability. Least viability is shown by *T.procumbens*.

Although cutting test do not give very accurate result but these are used extensively when seeds are fresh, but indigo carmin and tetrazolium test in *Datura*, *Argemone* and *Cassia* show good degree of viability, while that of *Boerhaavia* and *Tridax* less viability.

6. Seed Germination :

Some aspects of germination were considered in this chapter so that an ideal set of conditions can be maintained for the purpose of good germination percentage.

Seed germination involves absorption of water, enzymatic activity which increases the respiration and assimilation rates and then cell enlargement and cell division resulting in emergence of root and plumule growth.

Imbibition period and seed germination showed variation in different species. In general, in all cases increase in hours of imbibition increases the germination percentage but in different species it is different because of the nature of seed coat and its hardness.

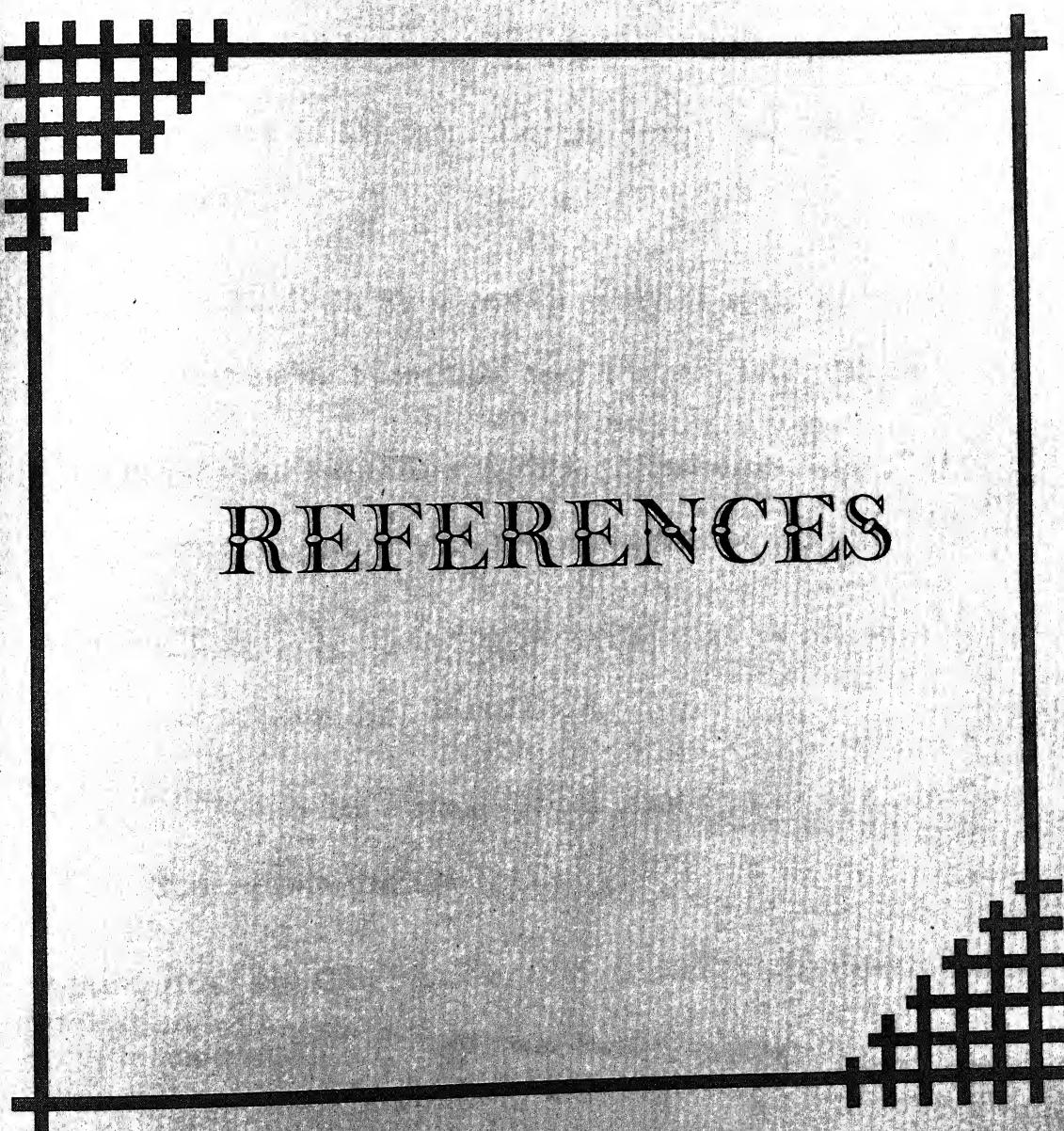
The effect of light condition shows that the germination percentage was higher in semishady condition followed by shady condition and was less in full sunlight.

Effect of storage period showed that there was a decline in germination percentage from fresh seeds to 12 months stored seeds.

Effect of different potting media on seed germination of these species reveals that the best media was soil and sand in equal

proportion (1:1). This appears to be due to water retaining capacity, increased aeration, which favours germination.

Effect of different concentrations of hormones indicate that 1-2 ppm of IAA treated seeds showed better germination, while with increase in IAA concentration there was a decline in germination percentage. IBA and GA₃ showed insignificant effect on germination percentage.



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* Original not seen.
